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VOL. XII.

1889-90.

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GEO. W. HARPER, O. D. NORTON,
H. P. SMITH, J. A. HENSHALL,
DAVIS L. JAMES.

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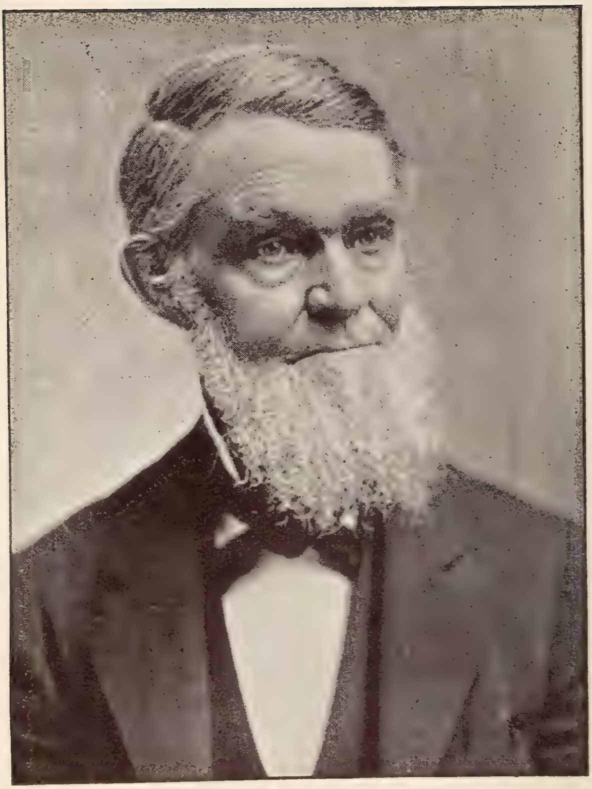

Very truly

U. P. James.

THE JOURNAL

OF THE

Cincinnati Society of Natural History

Vol. XII. CINCINNATI, APRIL, 1889. No. 1.

PROCEEDINGS.

BUSINESS MEETING, *Jan.* 8, 1889.

President J. Ralston Skinner in the chair.

The room was well filled with members and visitors.

The minutes of the October business meeting were read and approved.

The minutes of the Executive Board for meetings of October, November and December were read.

The following gentlemen were proposed for active membership: E. A. Daumont, Russell Hinman, and Silas T. Jennings.

The following gentlemen were elected to active membership: Alfred Warren, John E. Bell, and Dr. J. S. Newberg.

Dr. W. S. Christopher was elected a member of the Executive Board in place of Rev. R. Benjamin, resigned.

The resignation of Julius Dexter as Trustee was read and accepted.

The thanks of the Society were extended to Mr. Dexter for his past services as Trustee.

Wm. P. Anderson was nominated for Trustee in place of Julius Dexter, resigned.

Dr. A. J. Howe read a paper on the "Manatee," illustrated by a large drawing, and a skull of the animal.

Dr. J. A. Henshall being called on, made a few remarks on the Manatee of Florida.

The thanks of the Society were tendered Drs. Howe and Henshall.

Donations were received as follows:

From Mrs. Sarah Boggs, Newport, Ky., skin of a snake; from Dr. C. H. Ware, city, specimen of Orthoceras.

Adjourned.

SCIENTIFIC MEETING, *February* 5, 1889.

Vice-President Wm. Hubbell Fisher in the chair.

The minutes of the December scientific meeting were read and approved.

The following persons were proposed for active membership:

Jos. Eichberg, Mrs. Herbert Jenney, Wm. McMiller, Geo. B. McMiller, R. A. Holden, A. L. Fogg, G. A. Bowen, Wm. Simpkinson, Robt. Newlin, W. C. Emerson, Dr. Wm. Owen, Jr., E. S. Butler, H. T. Smith, Alfred Petry, Geo. Leach, Dr. A. Hoeltge, Wm. Porter Davis, Aaron Prince, Clarence Bartlett, Mrs. A. B. Thrasher, W. St. J. Jones, J. M. Cochran, E. H. Barton, John M. Kay, E. E. Shipley, C. J. Strong, H. Gibert, W. Boone, C. H. Sheen, M. A. High, H. J. Buntin, Wm. A. Gamble, R. T. Dickson, Miss Louise Devereux, Wm. Holden, Howard Carey, John A. Krumme, Jr.

The following were elected to active membership:

Edward O. Ulrich, Silas T. Jennings, E. A. Daumont, and Russell Hinman.

Mr. John Monteith, having just returned from Europe, made some remarks on foreign museums of Natural History.

Dr. A. J. Howe read a paper by title on "Heredity."

Horace P. Smith read a paper by Wm. T. Moorehead on the "Excavation of the Porter Mound."

Wm. P. Anderson was elected a Trustee in place of Julius Dexter, resigned.

Donations were received as follows:

From Mrs. Chas. A. Parke, Owen's Geological Survey of Wisconsin, Iowa and Minnesota; from O. P. Jenkins and B. W. Evermann, Descriptions of Fishes from Gulf of California.

Adjourned.

SCIENTIFIC MEETING, *March* 5, 1889.

President J. Ralston Skinner in the chair.

Horace P. Smith acting Secretary in the absence of Dr. J. A. Henshall, in Florida.

The minutes of the February scientific meeting were read, and after correction, approved.

The room was well filled by members and visitors.

Dr. A. J. Howe read a paper on "Heredity."

Dr. Davis L. James read by title the following papers: "Notes upon a Collection of Shells from Borneo, with descriptions of New Species," by T. H. Aldrich; and a "Monograph of the Lycoperdaceæ of the United States," by A. P. Morgan.

President Skinner read a paper on the "History and Condition of the Society," to be approved by the Society, and printed and presented to the Board of Public Works of the City of Cincinnati, with a petition praying for a site in Eden Park, for the erection of a suitable building for the Society.

After an informal discussion of the subject, the paper of President Skinner was approved and adopted, and the Executive Board authorized to proceed in the matter according to their judgment.

Dr. O. D. Norton read a letter on the Artesian Wells of the Belding Silk Company, at Northampton, Mass.

Mrs. Harry Rosenbaum was proposed for active membership.

The following persons were elected to active membership:

Miss Louise Devereux,	John M. Kay,
Mrs. A. B. Thrasher,	Emory H. Barton,
Mrs. Herbert Jenney,	Aaron Prince,
W. St. J. Jones,	J. M. Cochran,
Chas. Porter Davis,	E. E. Shipley,
Chas. J. Strong,	W. Boone,
M. A. High,	Harry T. Smith,
Wm. McMiller,	Geo. B. McMiller,
Reuben A. Holden, Jr.,	Robert Newlin,
Dr. Wm. Owen, Jr.,	Alfred Petry,
Edw. S. Butler,	Clarence Bartlett,
Howard Carey,	Jos. Eichberg,
Dr. A. Hoeltge,	W. C. Emerson,
W. Simpkinson,	Geo. A. Bowen,
C. H. Sheen,	Herbert Gibert,
H. J. Buntin,	Wm. A. Gamble,
Russell T. Dickson,	Jno. A. Krumme, Jr.,
Arthur L. Fogg,	Wm. Holden.
Geo. H. Leach,	

Mr. Davis L. James and Prof. Jos. F. James offered the following amendment to the Constitution:

To add to section 2, of Article VI., of the Constitution, after the words "the President,"—"the ex-Presidents, so long as they continue members of the Society,"—so that the section shall read: "The President, the ex-Presidents so long as they continue members of the Society, two Vice-Presidents, etc."

Mr. Davis L. James stated that the purpose of the amendment was to hold to active interest in the Society all ex-Presidents, and to keep

in the Executive Board persons whose experience and acquaintance with the business of the Society should not be confined to a single year's duration.

Vice-President Wm. Hubbell Fisher announced that since the last meeting of the Society an old and highly valued member, Mr. U. P. James, had departed this life, and moved that the President appoint a committee to prepare a suitable memorial of Mr. James.

The motion being carried, the committee was appointed and comprised the following: Dr. A. J. Howe, Wm. Hubbell Fisher, and Dr. A. T. Keckeler.

Donations were received as follows: from S. E. Wright, Vol. I., Nos. 1 and 2, Vols. II., III., IV., V., VI., VII. and VIII., complete, Vol. IX., No. 1, of Journal C. S. N. H.; from E. O. Ulrich, Monograph on Bryozoa.

Adjourned.

IN MEMORIAM.—U. P. JAMES.

(Read April 2, 1889, and ordered to be spread upon the Minutes.)

Mr. President:—The committee appointed by you to prepare a memorial of our associate, the late U. P. James, beg leave to offer the following report.

Uriah Pierson James, to whose memory a tribute of profound respect is due from this Society, was born at Goshen, Orange County, New York, on the 30th day of December, 1811, and died at his home near Loveland, Ohio, on February 25th, 1889. Thomas James, the father of Uriah, died while the son was quite young. Rhoda Pierson, the widowed mother, then moved with her family to Newark, New Jersey, where the subject of this sketch and his older brother were put to trades. The elder learned to be a printer, and Uriah was apprenticed to a shoemaker. He afterward worked in the manufacture of patent leather.

In 1831, the two brothers removed to Cincinnati, arriving August 6th, and soon started a stereotype foundry and printing office. Afterward Uriah P. James commenced the publication of books: and the business gradually grew to considerable proportions. The place of business at that time was on Fifth Street, near Home, and was afterward removed to Baker Street, between Walnut and Vine.

About 1840, U. P. James opened a book-store on Pearl Street, between Main and Walnut, and in 1847 formed a partnership with his brother Joseph, under the name of J. A. & U. P. James, opening a store at 167 Walnut Street, a site which is now a part of the Gibson House. They remained in partnership until 1854, when the firm dissolved, U. P. continuing the business for himself till 1886, when he finally retired in favor of his son, Davis L. James.

In 1844, U. P. James was elected a member of the Western Academy of Sciences, and from that time until the final dissolution of the Academy he continued an active member, serving as President, Vice-President and Treasurer during a long course of years. He was Treasurer of the Academy at the time its library, cabinet and funds were transferred to the Cincinnati Society of Natural History.

In 1871, Mr. U. P. James published a Catalogue of the Fossils of the Cincinnati Group collected in the vicinity of the city, embracing

specimens and observations reaching through a period of thirty years; and in 1878 he issued the first number of the *Palæontologist.* After seven numbers were issued, the journal was discontinued through lack of strength on the part of the editor. However, he contributed occasionally to the pages of the JOURNAL of the Society of Natural History, and his final work was the publication, with the assistance of his son Joseph, of a Monograph of the Monticuliporoid Corals of the Cincinnati Group. This work was published in three numbers of the Society's journal in 1887-8.

Mr. U. P. James amassed a large cabinet of shells and fossils. In the earlier days of his collecting in this vicinity, he gathered many rare and valuable fresh-water shells, which have since become exceedingly rare, if not absolutely extinct.

In his later labors, he confined his attention entirely to palæontology, and for nearly fifty years did not miss adding some fine specimen to his collection.

The *American Geologist,* in a coming issue, is to embrace a full sketch of his palæontological work, together with a complete list of his writings.

Considering the long and arduous labors of U. P. James in the field of scientific inquiry, and the marked integrity of the public spirited citizen, it is fit and proper that the Society of Natural History take action of a memorial character upon the death of a veteran associate whose mortal parts have recently been removed from associations and pursuits so genial to him. So well did he enjoy his labors, that he seemed to receive ample reward as he went along. He lived a long, useful and honored life; and in death was lamented by a wide circle of esteemed fellow-citizens. His early associates in scientific labor were among the most distinguished of Cincinnati's citizens, many of whom are no longer among the living. By the individual and united efforts of these men a half century ago, a nucleus in Science was established, which has culminated in this honored and prospered institution which we take pride in representing.

By the noble endeavors of a past generation of wise men, we are enabled to continue the good work so auspiciously begun. Here, later coming members, possessing kindred tastes, may catch the inspiration of their predecessors, and transmit the fruit of early laborers to a succeeding generation of scientific enthusiasts. Only thus may a great and grand cause flourish and be perpetuated.

In 1872, in consideration of valuable donations from the Western Academy of Natural Sciences, the Cincinnati Society of Natural History conferred life-memberships upon Messrs. Robert Buchanan, U. P. James, Robert Clarke, George Graham, D. E. Bolles, S. T. Carley, and John A. Warder; and we are pained to say that only two of the revered group still live to enjoy the privilege conferred upon them, as a responsive recognition of the substantial benefits bestowed by them and gratefully accepted by us. May we ever cherish the memories of these men, emulating their many virtues, and endeavoring to supply their places in this Association.

In presenting this tribute of deference to the memory of one deserving of homage, we respectfully submit the following testimonial:

Resolved: That in the demise of our revered associate, U. P. James, the Cincinnati Society of Natural History has been bereft of one of its most esteemed and useful members; and that our profound sympathies be hereby extended to the relatives of the bereaved family.

A. J. Howe,
Wm. Hubbell Fisher, } Committee.
A. T. Keckeler.

NORTH AMERICAN FUNGI.

BY A. P. MORGAN.

Second Paper.

(*Continued from Vol. XI., p.* 149.)

(Read March 5, 1889.)

THE GASTROMYCETES.*

Order II.—LYCOPERDACEÆ.

Mycelium filamentous or fibrous, rooting from the base or sometimes proceeding from all points of the surface. Peridium composed of two distinct layers, subglobose, sessile but commonly with a more or less thickened base, sometimes definitely stipitate. Gleba at first white, cellulose, the hymenium lining the walls of the cells; at length when the spores begin to ripen, dissolved with copious effusion of water; finally after maturity drying up into a dusty mass of mingled threads and spores.

Fungi mostly terrestrial, a very few species lignatile, epigœus sometimes hypogœus. In all the species of this order there is a double peridium, and correspondingly there is present in all of them those peculiar threads mingled with the spores, which in the aggregate are called the *capillitium*. The outer peridium may be a firm, persistent coat, at first inclosing the inner peridium, then opening in different ways; or more commonly it is a soft, fragile layer, often with external projections in the shape of warts, spines, or scales; in this case it is usually termed the *cortex*. The threads of the capillitium are uni-

*After the first paper went to press I received a pamphlet entitled "Morels and Puffballs of Madison, Wis., by William Trelease." This is the first attempt to give a systematic account of the Gastromycetes of any region of the United States. In it a few species hitherto unknown are added to the flora of the country, and the distribution of several others is extended. The paper is specially valuable for its criti al observations on the species, and for the independent measurement of the spores.

A. P. M.

cellular and continuous, or only with an occasional transverse septum; they may be hyaline or colored, and simple or variously branched: in form and size and in their origin they vary greatly, hence they serve admirably the purpose of classification.

TABLE OF GENERA OF LYCOPERDACEÆ.

I. VOLVATÆ. Outer peridium a thick, firm, persistent coat, bursting irregularly, or splitting from the apex downward into segments.

a. Inner peridium stipitate, the outer remaining as a volva at the base of the stipe.

1. POLYPLOCIUM. Inner peridium pileate, with aculeiform processes underneath; threads of the capillitium slender, hyaline, scarcely branched.

2. BATARREA. Inner peridium circumscissile, the upper part coming off like a lid; threads of the capillitium with spiral markings.

b. Inner peridium sessile, the outer splitting into segments which become reflexed.

3. MYRISOTOMA. Inner peridium dehiscent above by many mouths; columella ———; threads of the capillitium simple, tapering to each extremity.

4. GEASTER. Inner peridium dehiscent at the apex by a single mouth; columella present; threads of the capillitium simple, tapering to each extremity.

5. ASTRÆUS. Inner peridium membranaceous, dehiscent at the apex by a single mouth; columella, none; threads of the capillitium very long, much branched and interwoven.

6. MITREMYCES. Inner peridium cartilaginous, dehiscent at the apex by a stellate fissure; columella, none; threads of the capillitium very long, much branched and interwoven.

II. CORTICATÆ. Outer peridium (*cortex*) a soft, fragile, more or less deciduous layer, often with external projections in the shape of warts, spines, or scales.

c. Peridium stipitate.

7. TYLOSTOMA. Peridium membranaceous, dehiscent by a regular apical mouth; threads of the capillitium very long, much branched and interwoven.

d. Peridium sessile, but with a more or less thickened base.

8. Calvatia. Peridium large, globose or turbinate, breaking up into fragments from above downward, and gradually falling away: threads of the capillitium very long, much branched and interwoven.

9. Lycoperdon. Peridium small, globose, obovoid or turbinate, membranaceous, dehiscent by a regular apical mouth, threads of the capillitium long, slender, simple or branched.

10. Bovistella. Peridium subglobose, membranaceous, dehiscent by a regular apical mouth; threads of the capillitium free, short, several times dichotomously branched.

e. Peridium sessile without any thickened base.

11. Catastoma. Peridium globose, subcoriaceous, dehiscent by a basal aperture; threads of the capillitium free, short, simple, or scarcely branched.

12. Bovista. Peridium subglobose, membranaceous, dehiscent by an apical mouth, or opening irregularly; threads of the capillitium free, short, several times dichotomously branched.

13. Mycenastrum. Peridium subglobose, very thick, coriaceous, the upper part finally breaking up into irregular lobes or fragments; threads of the capillitium free, short, with a few short branches and scattered prickles.

I. Volvatæ. Outer peridium a thick, firm, persistent coat, at first closely investing the inner peridium, then bursting above irregularly, or splitting from the apex downward into several segments; inner peridium sessile, or with only a short pedicel or definitely stipitate. Columella often present.

Genus I.—Polyplocium, Berk.

Volva ample, persistent, bursting irregularly; stipe fibrous, confluent with the peridium; inner peridium hemispheric, then explanate, pileate, underneath gyrose-cellulose, at length splitting into thick aculeiform processes. Capillitium of slender hyaline threads, scarcely branched; spores subglobose, even, brown.

Plants growing in sandy soil in warm and dry regions. The genus is quite abnormal, being very closely related to the Agaricini, through *Montagnites*: the plants are very singular, and the early stages of their growth do not appear to be known.

1. P. inquinans, Berk. Volva cup-shaped, smooth, white; stipe thick, stout, tapering upward; inner peridium glabrous, by dryness areolate; spores ovoid, brown, 6–8 mic. in diameter.

Growing in sandy soil, California, *Harkness.* Volva 3 inches in diameter, stipe 4–6 inches in height, inner peridium 4–5 inches in breadth. The stipe is very thick and stout, sometimes as much as 2½ inches in diameter at the base within the volva, and 1 inch at the apex. In many cases the outer peridium does not rupture at all, the spores being set free from the destruction of the stipe by the larvæ of insects.

2. P. CALIFORNICUM, Hark. Outer peridium grayish, soon rupturing and widely separated by the slender elongating stipe; inner peridium flat or depressed; spores dark, reddish-brown, nearly globose, 6–8 mic. in diameter.

Growing on sand-hills west of San Francisco, Cal., *Harkness.* Stipe 4–8 inches in height, by ½ an inch in thickness, the pileate inner peridium 1–1½ inches in breadth. It is very distinct from the preceding species, and more nearly resembles *Montagnites Candollei, Fr.*

Genus II. BATARREA, Pers.

Outer peridium volviform, ruptured irregularly, persistent; stipe elongated, hollow, the surface lacerate into scales; inner peridium hemispheric, plane or concave underneath, dehiscent by a circular fissure beneath the margin, the upper part coming off like a lid. Capillitium of simple or branched threads with spiral or annular thickenings; spores globose, brownish.

Plants growing in sandy soil. The peridium originates deep down in the ground; at a certain stage of its development, the outer coat is burst and an axile portion of the basal cushion develops into an erect elongated stipe which lifts the inner peridium above the surface of the ground.

1. B. PHALLOIDES, Dicks. Outer peridium fleshy, ovoid, whitish, bursting irregularly at the apex; stipe long, cylindric, equal, fibrose-lacerate; inner peridium hemispheric, concave and smooth underneath, the upper part coming off like a lid. Spores brown.

Growing in the sand. San Francisco, *Torrey*; California and Arizona, *Harkness.* Peridium sunk in the ground to the depth of 7 or 8 inches, stipe attaining an altitude of nearly 1 foot, with a thickness of about ½ of an inch, inner peridium 2 inches in diameter. There does not appear to be any later description of this plant than the one quoted by Fries, S. M., Vol. III., page 7.

Genus III. MYRIOSTOMA, Desv.

Peridium subglobose, composed of two distinct persistent coats;

outer peridium thick, fleshy-coriaceous, at maturity splitting from the apex downward into several segments which become reflexed; inner peridium thin, membranaceous then papyraceous, supported on several short pedicels, and emitting the spores through one to many mouths. Threads of the capillitium simple or rarely branched, tapering to each extremity; spores globose, minutely warted, brown.

A genus of very singular plants, comprising at present but two species, the individuals of which are rarely met with.

I. M. COLIFORME, Dicks. Peridium subglobose, whitish, wrinkled and scaly; outer peridium multifid, reflexed; the segments 4–10, usually 7, acute at the apex; inner peridium globose or depressed-globose, gray or brownish, silvery shining, minutely warted; the small mouths numerous (3-50), at first papilliform, then a little elevated and ciliate, scattered irregularly over the upper surface. Threads of the capillitium simple or very rarely branched, tapering to each end, brown; spores globose, minutely warted, brown, 5–6 mic. in diameter. See Plate I, A.

Growing in sandy soil. Colorado, *Chas. H. Peck.* Inner peridium 1–2 inches in diameter, the outer peridium expanding to a breadth of 3–6 inches, the small pedicels 2–5 mm in hight. The plant is said to be at first sunk deep in the ground, and therefore is probably connected with the soil by a superficial filamentous mycelium. The related *M. columnatum*, Lev., which grows in Chili, emits the spores by a single fimbriate mouth.

Genus IV. GEASTER, Mich.

Mycelium filamentous or fibrous, much branched and interwoven with the soil. Peridium subglobose, composed of two distinct persistent coats; outer peridium thick, fleshy-coriaceous, at first closely investing the inner but discrete, at maturity splitting from the apex downward into several segments which become reflexed; inner peridium thin, membranaceous then papyraceous, sessile or with a short pedicel, dehiscent at the apex by a single mouth. Capillitium taking its origin from the inner surface of the peridium and also from a distinct central columella, which arises from its base; threads simple, long, slender, thickest in the middle and tapering to each extremity, fixed at one end and free at the other; spores small, globose, minutely warted, brown.

Plants which grow just beneath the surface of the soil; when the outer peridium bursts the segments become reflexed and lift the inner

peridium up into the air; the inner peridium remains seated at the center of the expanded outer peridium with the segments ranged around it like a star. Three layers may be distinguished in the structure of the outer peridium; first, the epidermis or *cuticle*, usually flaky and fragile; second, the middle *fibrillose layer* consisting of stout, closely woven hyphæ, running in the direction of the surface; third, the inner *fleshy layer*, thick when fresh and growing, but shrinking much in drying. The fibrillose layer is continuous at the base with the inner peridium, which has a similar structure, and projects into it as the columella; when the fleshy layer is quite thick, the connection between the *two* appears as a short pedicel after the former has shrunk in drying.

TABLE OF SPECIES OF GEASTER.

§1. DEPELLITI. Peridium depressed-globose, not pointed; the segments acute at the apex.

I. PEDICELLATI. Outer peridium conspicuously vaulted underneath; inner peridium with a distinct pedicel.

a. Mouth sulcate-plicate 1, 2, 3.

b. Mouth ciliate-fimbriate 4, 5, 6.

II. SESSILES. Outer peridium with the base convex, not vaulted; inner peridium sessile.

c. Mouth sulcate-plicate 7.

d. Mouth ciliate-fimbriate 8, 9.

e. Mouth dentate or lacerate 10, 11.

§2. PELLICULOSI. Peridium ovoid, pointed; the segments acuminate at the apex.

III. SACCATI. Outer peridium with the base saccate; inner peridium sessile.

f. Mouth sulcate-plicate 12.

g. Mouth ciliate-fimbriate 13, 14, 15.

§1. DEPELLITI. *Peridium depressed-globose, not pointed; the segments acute at the apex.* The peridium is at first sunk deep in the soil and connected with it by an abundant filamentous mycelium, which issues from every part of the surface; at maturity, when the outer peridium expands its segments, the mycelium being held fast by the soil, strips off the cuticle from the fibrillose layer.

I. PEDICELLATI. Outer peridium multifid, becoming wholly reflexed and conspicuously concave or vaulted underneath, often lifted up on

the extremities of the segments, which become inflexed at the apex in drying; inner peridium with a distinct pedicel, which corresponds in length to the thickness of the fleshy layer.

a. Mouth sulcate-plicate.

1. G. FORNICATUS, Huds. Outer peridium subquadrifid, the segments 4 or 5, rarely more; inner peridium obovoid, pedicellate, bluish gray or brownish; the mouth prominent, conic, sulcate-plicate. Columella slender, subclavate; threads of the capillitium thicker than the spores, brown; spores subglobose, minutely warted, brown, 4–5 mic. in diameter.

Growing on the ground among the leaves of Coniferae. New York, *Peck;* North Carolina, *Schweinitz*, *Curtis*; South Carolina, *Ravenel.* Inner peridium ½–¾ of an inch in diameter, the breadth of the expanded segments 1–2 inches. This is *G. quadrifidum* of Schweinitz's N. A Fungi.

2. G. CAMPESTRIS, Morg. Outer peridium multifid, the segments 8–10; inner peridium globose, pedicellate, verrucose, gray or brownish; the mouth conic, sulcate-plicate, seated in a circular marginate disk. Columella globose, with a broad base; threads of the capillitium about as thick as the spores, hyaline; spores globose, minutely warted, brown, 5–7 mic. in diameter.

Growing in clusters on the open prairie about Lincoln, Neb. *Chas. E. Bessey.* This appears to be what *Cragin* refers to *G. granulosus*, Fckl. Inner peridium ⅜–¾ of an inch in diameter, the expanse of the segments 1–2 inches. In many specimens the mycelium and cuticle seem quite persistent, giving the outer surface a coating of soil.

3. G. BRYANTII, Berk. Outer peridium multifid, the segments 8–10; inner peridium broadly obovoid, gray or brown, tinged with blue, with a projecting collar below encircling the apex of the long pedicel; mouth prominent, conic, sulcate-plicate. Columella globose, with a thick base; threads of the capillitium about as thick as the spores, brown; spores globose, minutely warted, brown, 4–5 mic. in diameter.

Growing on the ground in woods. New York, *Chas. H. Peck.* Inner peridium ¾–1 inch in diameter, the expanse of the segments 2–3 inches. The collar or small inverted cup at the base of the inner peridium into which the apex of the pedicel is inserted will distinguish this species from the others that are closely related. The cup

or depression about the base of the pedicel in some specimens results from the shrinking of the fleshy layer in drying.

b. Mouth ciliate-fimbriate.

4. G. LIMBATUS, Fr. Outer peridium multifid, the segments 7-10; inner peridium globose or broadly obovoid, somewhat depressed above, pale to dark brown, pedicellate; the mouth little elevated, somewhat lacerate, ciliate-fimbriate. Columella very large, convex or conic, with a broad flaring base, occupying about a third part of the peridium; threads of the capillitium, thicker than the spores, brown; spores globose, minutely warted, brown; 4–5 mic. in diameter. See Plate I., B.

Growing in the rich soil around old stumps. New England, *Frost;* North Carolina, *Curtis;* Alabama, *Peters;* Ohio, *Morgan;* Wisconsin, *Trelease*; Kansas, *Cragin.* Inner peridium ¾–1½ inches in diameter, the expanded segments with a breadth of 2–4 inches. This is the commonest Geaster in the Miami Valley; I have found as many as thirty plants growing at once around an old oak stump. The inner peridium is usually slightly constricted around the lower part just above the edge of the columella. From the imperfect description of *G. radicans*, B. and C., it is impossible to tell wherein it differs from the present species. Possibly *G. turbinatus* Cragin is something different, but we have seen no specimens.

5. G. SCHÆFFERI, Vitt. Outer peridium multifid, the segments 4–8; inner peridium globose, pedicellate, sooty-white; the mouth somewhat prominent, dentate, the teeth fimbriate. Columella globose, with a narrow base; the threads of the capillitium brown; spores globose, brown.

Growing on the ground in woods. Catskill Mountains, N. Y., *Chas. H. Peck.* Inner peridium less than ½ an inch in diameter, the expanse of the segments an inch or more. The fresh specimen is figured with the pedicel sunk in the fleshy layer.

6. G. MINIMUS, Schw. Outer peridium multifid, the segments 7–9; inner peridium ovoid, pedicellate, white to pale brown; the mouth conic, ciliate-fimbriate, seated in a plane circular disk. Columella slender, nearly obsolete; threads of the capillitium thinner than the spores, hyaline; spores globose, minutely warted, brown 3.5–4.5 mic. in diameter.

Growing in grassy grounds. New England, *Frost*; New York, *Peck*; Pennsylvania, *Schweinitz*; New Jersey, *Ellis*; North Carolina, *Schweinitz*, *Curtis*; Ohio, *Morgan.* Inner peridium ¼–½ of an inch

in diameter, the segments expanding ½–1 inch. A very pretty little Geaster, difficult to find amongst the grass. It is sometimes found with the circular marginal chink around the mouth as in *G. marginatus*, Vitt.

II. Sessiles. Outer peridium multifid or sometimes deeply parted, with only the segments reflexed; the base convex below, not vaulted; the fleshy layer thin; inner peridium sessile.

c. Mouth sulcate-plicate.

7. G. umbilicatus, Fr. Outer peridium multipartite, the segments 7–10; inner peridium globose or depressed-globose, sessile, brown; the mouth conic, sulcate-plicate, seated in a circular depressed marginate disk. Columella slender, cylindric, with a broad base; threads of the capillitium rather thicker than the spores, pale brown, spores globose, minutely warted brown, 3.5–4 mic. in diameter.

Growing on sandy soil. New Jersey, *Ellis*. Inner peridium about ½ of an inch in diameter, the segments unequal, lanceolate. A beautiful little species, readily distinguished by the depressed marginate mouth, elegantly plicate and furrowed. It is *G. mammosus* No. 110 of Ellis's N. A. Fungi.

d. Mouth ciliate-fimbriate.

8. G. mammosus, Chev. Outer peridium multipartite, the segments 7–10, hygrometric; inner peridium depressed-globose, sessile, pale or yellowish to brown; the mouth slightly elevated, ciliate-fimbriate, seated in a paler circle. Columella short, cylindric, with a broad convex base; threads of the capillitium rather thinner than the spores, pale brown; spores globose, minutely warted, brown, 5–6 mic. in diameter.

Growing in sandy soil. California, *Harkness*. Inner peridium about ½ of an inch in diameter, the segments with a brown cartilaginous-gelatinous layer which is strongly hygrometric. There is much discrepancy among authorities as to the size of the spores; we have given our own measurement of the spores in specimens which are supposed to be authentic.

9. G. fimbriatus, Fr. Outer peridium multifid, the segments 5–10; inner peridium globose, sessile, pallid to pale brown; mouth little elevated, hairy-fimbriate. Columella obovoid or subclavate; threads of the capillitium nearly twice as thick as the spores, pale brown; spores globose, even or very minutely warted, pale brown, 3–3.5 mic. in diameter.

Growing on the ground in woods. New England, *Frost;* North Carolina, *Curtis*; South Carolina, *Ravenel;* Kansas, *Cragin*; California, *Harkness.* Inner peridium ¾–1 inch in diameter, the segments expanded 2–3 inches in breadth. The outer peridium casts off a thick cuticular layer when it expands, and the fleshy layer soon secedes, leaving in the dried specimens commonly nothing but the thin, flaccid fibrillose layer.

e. Mouth dentate or lacerate.

10. G. RUFESCENS, Pers. Outer peridium multifid, the segments 6-8; inner peridium globose or broadly ovoid, sessile, pallid; mouth little elevated, dentate, the ciliate fringe entirely wanting. Columella subglobose, small; threads of the capillitium pale brown; spores globose, even or very minutely warted, 3.5–4.5 mic. in diameter.

Growing on the ground in pine woods. North Carolina, *Schweinitz;* California, *Emory.* Inner peridium 1–1½ inches in diameter, the expanse of the segments 3–4 inches. The inner fleshy layer and also the cuticle seem quite persistent, differing in this respect as well as in the nature of the mouth from *G. fimbriatus*, to which it must be closely related.

11. G. DELICATUS, Morg. Outer peridium thin, multifid; the segments 6–10, unequal; inner peridium sessile, depressed-globose, pallid to pale brown; the mouth plane, lacerate. Columella cylindric or nearly obsolete; threads of the capillitium thinner than the spores, hyaline; spores globose, minutely warted, pale brown, 5.5–6.5 mic. in diameter.

Growing in sandy soil. Nebraska, *Chas. E. Bessey;* California, *Ellis.* Inner peridium ¼–½ of an inch in diameter, the expanse of the segments an inch or more; the thin inner layer is somewhat hygrometric; the mouth is sometimes a mere slit or puncture.

§2. PELLICULOSI. *Peridium ovoid, pointed, the segments acuminate at the apex.* Mycelium fibrous, proceeding from the base of the peridium, much branched and interwoven with the soil; cuticle persistent, subtomentose, often splitting lengthwise in drying.

III. SACCATI. Outer peridium multifid, the segments reflexed with the base saccate, or sometimes revolute with the base plane; inner peridium sessile or subpedicellate.

f. Mouth sulcate-plicate.

12. G. STRIATUS, DC. Outer peridium multifid, the segments 7–10; inner peridium globose, sessile or subpedicellate, pale to dark

brown, punctulate; the mouth prominent, conic, sulcate-plicate. Columella subclavate; threads of the capillitium much thicker than the spores, brown; spores globose, minutely warted, brown, 3.5–4.5 mic. in diameter.

Growing about old stumps or rotten logs. New York, *Peck*; North Carolina, *Schweinitz*; Ohio, *Morgan*; Illinois, *Andras*; California, *Harkness*. Inner peridium ½–¾ of an inch in diameter, the expanded segments with a breadth of 1½–2 inches. In fresh specimens the segments are often strongly revolute. This is *G. pectinatus* of Schweinitz's N. A. Fungi. *G. striatus*, DC. *var. minor*, Fr. of Lea's Catalogue applies to those specimens which have a pale inner peridium. A very common species in the Miami Valley.

G. Mouth ciliate-fimbriate.

13. G. TRIPLEX, Jungh. Outer peridium 4–6-parted, the thick fleshy layer breaking away about the middle and forming a cup; inner peridium depressed-globose, sessile, pallid or brownish; the mouth broadly conic, ciliate-fimbriate, seated in a definite circular area. Columella clavate, reaching to the center: threads of the capillitium much thicker than the spores, pale brown; spores globose, minutely warted, pale brown, 4.5–5.5 mic. in diameter.

Growing gregariously in the rich soil about old stumps. Tennessee, *Wetherby*; Ohio, *Morgan*; Michigan, *Foerste*. Inner peridium ¾–1½ inches in diameter, expanse of the segments 3–4 inches. One of the largest and finest species of Geaster.

14. G. SACCATUS, Fr. Outer peridium multifid, the segments 6–9; inner peridium globose, sessile, pallid or brownish: the mouth conic, ciliate-fimbriate, seated in a definite circular area. Columella subclavate, reaching the center; threads of the capillitium much thicker than the spores, pale brown; spores globose, minutely warted, 3–3.5 mic. in diameter. See Plate I., C.

Growing in rich soil in woods. New England, *Morgan*; New York, *Peck*; North Carolina, *Curtis*; Alabama, *Peters*; Ohio, *Morgan*; Wisconsin, *Trelease*; Nebraska, *Webber*; Kansas, *Kellerman*. Inner peridium ½–¾ of an inch in diameter, the segments expanding to a breadth of 1½–2 inches. The segments at maturity are usually only reflexed, while the base remains saccate holding the inner peridium as in a cup. *G. capensis*, Thum., is said to be only a form of this species; *G. vittatus*, Kalch., applies to specimens of this species with the cuticle split into parallel lines lengthwise of the segments.

15. G. LAGENIFORMIS, Vitt. Outer peridium multifid, the segments 6–9; inner peridium ovoid sessile, pallid or brownish; the mouth prominent, conic, ciliate-fimbriate, seated in a definite circular area. Columella slender, subclavate or nearly obsolete; threads of the capillitium thicker than the spores, pale brown; spores globose, even or very minutely warted, 2.5–3.5 mic. in diameter.

Growing on the old leaves in woods. Ohio, *Morgan.* Probably occurring elsewhere along with *G. saccatus*, of which it may be but a small variety. Inner peridium usually less than ½ of an inch in diameter, though larger specimens with the inner peridium ovoid sometimes occur.

16. G. FIBRILLOSUS, Schw. "Outer peridium multipartite, inflexed, externally fibrillose-scaly; inner peridium sessile, even, dehiscent." *Schweinitz Syn. Car.*, *No.* 330.

"Related to the preceding (viz., *G. hygrometricus*), but the segments of the outer peridium more numerous, acuminate, with an expanse of 2 inches, externally not glabrate, within rufescent; inner peridium not reticulate, subglobose; sporidia bay. The single specimen is imperfect, closely infolding its segments as in the preceding. Upon the bare ground, Carolina." *Fries, S. M., Vol. III., p.* 20.

"Also in Pennsylvania, usually upon old prostrate trunks, arising out of the rotten bark. Sometimes elegantly areolate with fibrils." *Schweinitz N. A. Fungi, No.* 2251.

This species does not appear to have been recognized since by any other person. What its relationship may be it is impossible to infer from the description.

Genus V.—ASTRÆUS, Morg. Nov. gen.

Mycelium fibrous, proceeding from all parts of the surface. Peridium subglobose, composed of two persistent coats; outer peridium thick, coriaceous-cartilaginous, at first concrete with the inner peridium, then at maturity burst into segments and torn away; inner peridium thin, membranaceous, sessile, dehiscent at the apex by a single mouth. Columella none; capillitium originating from the inner surface of the peridium; threads long, much branched and interwoven; spores large, globose, minutely warted, brown.

A genus founded upon the well-known *Geaster hygrometricus*, Pers. The internal structure in this species is essentially different from that in all the Geasters of which we have any knowledge; first, the hymenial tissue fills or stuffs the cells of the gleba, as in *Scleroderma*:

second, the threads of the capillitium are long, much branched and interwoven, as in *Tulostoma*; third; the elemental hyphae of the peridium are scarcely different from the threads of the capillitium and are continuous with them, in this respect agreeing again with *Tulostoma*; fourth, there is an entire absence of any columella, in fact it is precluded by the nature of the capillitium; fifth, both threads and spores differ greatly in size from those of Geasters. It is impossible to define accurately the genus *Geaster* and retain this species within it.

1. A. HYGROMETRICUS, Pers. Peridium depressed-globose, the cuticle deciduous with the mycelium; outer peridium deeply parted, the segments 7–20, strongly hygrometric, acute at the apex; inner peridium depressed-globose, sessile, reticulate, pitted, whitish becoming gray or brownish; the mouth an irregularly lacerate aperture. Threads of the capillitium rather thinner than the spores, hyaline; spores globose, minutely warted, brown, 8–11 mic. in diameter. See Plate II., B.

Growing in fields and woods in sandy soil. New England, *Frost*; New York, *Peck*; Pennsylvania, *Schweinitz*, *Gentry*; North Carolina, *Schweinitz*, *Curtis*; South Carolina, *Ravenel*; Florida, *Calkins*; Texas, *Drummond*; New Mexico, *Wright*; Wisconsin, *Brown*, *Trelease*; Kansas, *Cragin*; California, *Harkness*. A very common species found everywhere in the world. Inner peridium ¾–1 inch in diameter, the segments expanding to a breadth of 2–3 inches. The inner layer of the outer peridium is cartilaginous-gelatinous, hard and rigid when dry, swelling greatly and flexible when wet; though constantly becoming more and more cracked and fissured, it retains its hygroscopic qualities a long time, and the outer peridium remains lying on the soil, stellate in shape, spreading out its rays in moist weather and bending them inward in dry.

Genus VI.—MITREMYCES, Nees.

Mycelium composed of numerous cord-like cartilaginous gelatinous fibers, which branch and anastomose into a dense net-work, thus forming a thick rooting base. Peridium subglobose, composed of two coats; outer peridium cartilaginous-gelatinous, thin and fragile when dry, thick, soft and flexible when wet, at first concrete with the inner peridium, then at maturity burst into segments and torn away. Inner peridium globose, composed of two layers; the outer layer cartilaginous, hard and rigid when dry, tough and flexible when wet; lining the inner surface of this is a very thin delicate membrane (*sacculus*)

which at maturity detaches itself and hangs suspended from the apex filled with the ripe spores, then by its gradual contraction expelling them: mouth a stellate fissure of several rays, the margins elevated. Capillitium originating from the hyphæ of the sacculus, similar to and continuous with them; the threads long, slender, hyaline, much branched and interwoven, after maturity soon broken up and disappearing; spores large, hyaline, variable in length.

Plants very remarkable both in their structure and substance. The rooting base is sunk in the soil and connected immediately with it, and is developed above into the peridium; the peripheral cords expand upward into the outer peridium with little change of substance, but in the inner peridium the hyphæ are thicker and more abundant and are interwoven into a tough membrane. The extensible gelatinous element prevails throughout every part of the plant, even in the threads and spores, being most abundant in the mycelium and outer peridium. A bright colored stratum of loosely woven hyphæ lies between the inner and the outer peridium; when the latter bursts this colored layer is torn apart in such a way that one portion lines the inner surface of the segments, the other covers the inner peridium. The little sac detaches itself when the outer peridium is thrown off, it then gradually contracts its volume, forcing out the spores through the fissured apex, the fine tender threads becoming dry are crushed into fragments and expelled along with the spores.

1. M. LUTESCENS, Schw. Peridium subglobose, with a thick entangled rooting base; outer peridium dull red, thin, smooth and shining when dry, swelling greatly and paler when wet, with a scarlet lining, bursting into 5 or 6 segments which roll inward and hang about the base of the peridium or fall away. Inner peridium globose, bright scarlet fading to yellowish and pallid, apical fissure about 6-rayed, the bright color quite persistent on and within the margins; sacculus thin, soft, flexible, white or yellowish. Mass of spores and capillitium compact, white or yellowish, the threads very slender, branched, hyaline, evanescent; spores varying from globose or oval to oblong and cylindric, 10–25 mic. in length by 8–10 mic. in breadth. See Plate II., A.

Growing on the ground in the woods. New England, *Hitchcock;* New York, *Schweinitz;* Pennsylvania, *Schweinitz*, *Rau*, *Gentry;* Carolina, *Curtis*, *Ravenel*, *Atkinson*; Texas, *Drummond*. Inner peridium ½–1 inch in diameter when moist; a dry specimen with the outer peridium entire will more than double its diameter when soaked

in water; the rooting base is quite variable in size. This name under which the species commonly appears was given by Schweinitz in the Syn. Fung. Carolinæ Superioris; a few years later it was figured and described in Silliman's Journal, Vol. IX., page 56, pl. 3, by Edward Hitchcock, as *Gyropodium coccineum*, a name which he ascribes to Schweinitz; it was, however, described, even before the time of Linnaeus, by Dr. Plukenet, in the brief fashion of the time, as "Fungus pulverulentus, virginianus, caudice corallino, topiario arte contorto," which presents quite a contrast to the elaborate description required at the present day. M. *cinnabarinus* of Schweinitz's N. A. Fungi is evidently this same species. I have never been able to distinguish more than one species in this country, and have regarded *M. Ravenelii*, Berk., as based upon small specimens of *M. lutescens.*

NOTES UPON A COLLECTION OF SHELLS FROM BORNEO WITH DESCRIPTIONS OF NEW SPECIES.

By T. H. Aldrich.

(Read March 5, 1889.)

During the past year I had the pleasure of receiving a small collection of shells from William Doherty, Esq., formerly of Cincinnati, who gathered them in the Kusan and Penggiron districts in Southeastern Borneo and from the Kinan and Kiwa Rivers.

The localities are comparatively new, and the distribution of Bornean species so little known, that this list is offered to extend the information derived from the collection. Examples of many of the species mentioned are now in the collection of the Society.

1. *Clea nigricans*, Adams.

Four specimens received, two young and two adult.

2. *Melania brookii*, Rve. var.

The specimens differ from the typical form considerably. One example is subscalaroid, and all are nearly smooth, the more adult ones show traces of tubercles on the body whorl, which is also angulated at its periphery.

3. *Melania tuberculata, var. malayana*, Issel.

Prof. Brot, of Geneva, Switzerland, has kindly confirmed my determination, as well as the other fresh water species mentioned.

4. *Ampullaria pilula*, Rve.

Only young specimens received, but the determination is believed to be correct.

5. *Paludomus lacunoides*, n. sp. Pl. III., figs. 1, 1a, 1b and 1c.

Shell smooth, solid, obovate, spire moderate, whorls five? contracted below the suture and partially shouldered; color olive, in young specimens three broad bands are upon the body whorl and show through it; suture distinct. Base of body whorl obsoletely striated; aperture ovoid, over half the length of the shell; outer lip slightly denticulated, columella white, bordered with a flattened semilunar space behind.

Remarks: This species appears to be quite distinct from *Paludomus crassus* V. dem Bush. Prof. A. Brot, who suggested the specific name given, writes as follows: "It is not unlike *P. conicus*, Gray, (of which *P. crassus* is generally considered a variety, perhaps erroneously) but your specimens present a character quite unusual in the whole genus; the columellar margin is bordered by a semi-lunar flattened area, which fills the umbilical region, and is distinctly delimited by an acute ridge." Twenty specimens received.

6. *Nanina brookei*, Adams & Reeve.

Three magnificent examples of this species received. The largest 3½ inches in diameter.

7. *Nanina decrespignyi*, Higgins.

One specimen.

8. *Nanina mindaiensis*, Bock.

Six specimens received. This form shows but six whorls. There are several similar forms like *N. janus*, Chemn., *N. hugonis*, Pfr., and *N. amphidroma*, V. Martens, that may prove to be all one species.

9. *Nanina densa*, Ad. & Rve.

Six specimens. The darker colored ones equal *N. Schumacheriana*, Pfr.

10. *Nanina aglaja*, Pfr.

One specimen, close to *N. jucunda*, Pfr.

11. *Trochomorpha angulata*, Issel.

Three specimens.

12. *Trochomorpha kusana*, n. sp. Pl. III., figs. 3, 3a, 3b.

Shell minutely perforate, thin, subtrochiform, light horn color, translucid, with about three transverse raised striae parallel to the suture; whorls six, strongly rounded, the body whorl non-descending; spire obtuse; base rounded; aperture flattened, ovate, the transverse diameter the largest, peristome acute; columella reflexed at base and partially covering the umbilicus. Diameter, 3 mm. Altitude 2 mm.

Remarks: Seven specimens received. They differ in size and shape from *T. angulata*, Issel; both species, however, could just as well be placed with the section *Sitala* of the genus *Nanina.*

13. *Nanina (Microcystis) macdougalli?* Issel.

Twenty specimens, which agree with the description of the above species better than any other.

14. *Trochomorpha bicolor*, V. Martens.

Only one specimen.

15. *Trochomorpha planorbis*, Lesson.

Var appropinquata, V. Martens.

16. *Bulimus perversus* L.

About twenty specimens, part of which are sinstral. They are all without the characteristic yellow ground usually so strong in this species; they are strongly marked and resemble the variety *B. interruptus*, Brug. All are larger and more solid than usual.

Mr. Doherty states that each variety occupies a distinct area.

17. *Leptopoma lowi*, Pfr.

One specimen.

18. *Leptopoma sericatum*, Pfr.

One specimen

19. *Cyclophorus barbatus*, Pfr.

One young example.

20. *Cyclotus ptychoraphe*(?) V. Martens.

Two dead specimens.

21 *Pterocyclos tenuilabiatus*, Metcalfe.

Numerous examples.

22. *Opisthoporus euryomphalus*, Pfr.

Twenty-three examples.

23. *Alycæus*, n. sp. 7. Pl. III., figs. 2, 2a, 2b.

Two dead specimens received. They differ from anything I can find that has heretofore been described from Borneo. If new, I propose the name *Alycæus broti* for it, and append the following description:

Shell small, whorls fine, covered with strong, raised, vertical striae, finely set upon the body whorl. Apex smooth, whorls rounded, aperture twisted downward, almost vertically to plane of shell. Lip exserted and bordered by a reflected expansion. Umbilicus open, showing the convolutions of the shell. Diameter about 7 mm., height 3½ mm. This species resembles the Indian forms much more than those from Borneo. It may possibly be *A. spiracellum* Ad. & Rve, whose figure and description I have not had access to.

24. *Diplommatina concinna*, H. Adams.

One specimen.

25. *Clausilia* (*Euphœdusa*) *dohertyi*, Boettger, n. sp. Pl. figs. 4, 4a, 4b, 4c.

Upon submitting the form named as above to Herr. Boettger, of Frankfort am Main, Germany, he pronounced it quite distinct, and at my request named and described it as follows:

CLAUSILIA (EUPHÆDUSA) DOHERTYI n. sp.

T. vix rimata, clavato-fusiformis, gracilis, solidula, pallide corneo-lutea, ad suturam albidocingulata; spira elongato-turrita; apex acutiusculus, submamillatus. Anfr, 9½ lente accrescentes et laxe voluti, convexiusculi, sutura impressa simplici disjuncti, striatuli, ultimus praecedente angustior, cervice distinctius costulato-striatus, basi rotundatus nec compressus nec carinatus. Apertura anguste piriformis, breviter soluta sed superne recedens, sinulo sublimi; peristoma undique incrassatum sed non expansum et perparum solum reflexum, margine sinistro bene curvato et media parte subprotracto, dextro strictiuscule descendente. Periomphalum callosum, angustum, subplanum. Lamellæ sat validæ marginales, supera perobliqua, intus altior, cum spirali contigua vel continua, infera oblique ascendens sigmoidea, a basi intuenti spiraliter intrans, subcolumellaris longe emersa. Apparatus claustralis lateralis, plica principalis modica profundissime sita, ventrilateralis, palatales verae 2 breves, principali parallelæ, superior duplo longior quam inferior.

Alt. 17, diam. 3¾ mm; alt. apert. 3¾, lat ap. 2¾ mm.

Hab. S. E. Borneo.

Proxime affinis Cl. (Euphædusæ) Cumingianæ Pfr. insularum Philippinicarum et Moluccarum, sed colore pallidiore, papillis suturalibus nullis, apertura angustiore, peristomate non expanso, lam. subcolumellari emersa bene distincta.

(DR. O. BOETTGER).

EXPLORATION OF THE PORTER MOUND, FRANKFORT, ROSS COUNTY, OHIO.

By Warren K. Moorehead.

[Read February, 1889.]

This mound is situated within sight of the village of Frankfort. It is one of a group of seven mounds. The dimensions are as follows: Length 110 feet; width 62 feet; height 6 feet. It is stated by old residents that the mound was once twenty feet high.

Mr. Till Porter graciously accorded permission to open this structure, and accordingly work was begun on the morning of August 8, 1888. We were five days in completing this mound, a force of seven men and three teams being employed. There was a large sink hole near the mound, (the earth for its construction was probably taken from this depression), and we agreed to fill this hole up with the earth from the mound. For this reason we engaged teams as well as diggers.

We began on the south side. A trench nearly as wide as the mound itself was begun on the original surface. This was carried through the mound. Four feet from the outer edge on the south side we came upon a layer of coarse gravel boulders, two feet in width and three inches in thickness. From its curvature we judged it extended all around the mound. This conjecture was afterward confirmed by meeting with the circle on the north and east sides. About fourteen feet from the circle of stones, placed in a fine bed of sand, aperture downward, was a sea shell (Pyrula?) covering a few decayed human bones—fragments of a skull, but nothing whole, nor were any of the bones over one inch in diameter. Near this one, but placed near the surface of the mound, was a smaller shell of the same species.

Thursday afternoon, at about thirty feet from the stone circle we made the most remarkable discovery we were destined to participate in. Between two copper plates was a mass of copper earrings, beads, and decayed wood and cloth. These plates were placed horizontally, about an inch apart. The smaller one was uppermost. The sizes were 9½x7 inches and 8x6 inches. Between them were twenty copper earrings or brooches. Around the center of some of the brooches

were traces of rough thread or cord. These were carefully examined by an "expert" and pronounced fibre of slippery elm. Some of the brooches still held a rotten leather thong three inches in length. I tried to preserve this thong in several instances, but failed utterly. Below the brooches were 197 large shell beads. They were full size, very round, neatly drilled. At the bottom was the largest copper plate. The ends were curved inward. Traces of decayed wood were found above its. Some of this wood is well preserved, and showed plainly.

Work was then stopped on the south side and a trench begun on the north side. This was carried through until it met the southern excavation. We had scarcely gotten well under way when we came upon an object peculiar to the Scioto Valley mounds; *i. e.*, an altar. It was placed on the bottom, had been formed in situ. The dimensions were as follows: 30 inches long, 24 inches wide, 4 inches deep. A rim six inches wide extended around it. The depression in the center was 24x18x4 inches. It was filled with ashes and burned bones; was very symmetrical and nicely made. I had often heard of these regular altars being photographed or drawn; but never heard of one being taken out entire. I had the men dig around it very carefully; then had them when it was undermined all put their hands underneath and lift together. It weighed 300 pounds, yet it was taken out with scarcely a crack. It was packed in a box securely, and stored with Captain McGinnis for safe keeping. The altar is still with him. I would ship it, but am afraid it may be broken in transit.

The thickness of the altar was four inches. It was burned quite hard. The bottom was unshaped, and the top had been molded as described. It rested on small stones.

We connected the two trenches at the west end of the mound, to give a sharp point of ground to work on. We gradually worked this point backward, and this is what we found. In the south side on the bottom near the center was a long skeleton with head to the south. Just above the forehead were five bear teeth crossed like a rail fence. They had five perforations each. The perforation on the inner side has a plug inserted. This plug is made from the tooth of a ground hog. I have never before heard of teeth being so ornamented. Four brooches accompanied this skeleton. Just beyond this skeleton was a small ash-pit covered with a mica sheet. We found numbers of these pits in the mound. They were always on the bottom; varied from eight to ten inches in diameter and one foot in depth. Generally they

were covered with a plate of mica. In this one was a decayed fragment of skull, ashes, and 993 pearl beads. They are the fresh water mussel pearls, well drilled but poorly preserved. I neglected to state above, that two flat beads with two holes in them were found by the side of the skull of the skeleton above mentioned.

To return to the north side. When about fifteen feet from the stone circle there was uncovered a large ash-pit. It varied in depth from two to three feet; in extent it was eight by eleven feet. The soil was filled with pottery fragments, flint flakes, burnt hickory-nuts, animal bones, etc. At short distances there was a mica sheet covering an ash-pit. We dug out very carefully all these shallow holes in hopes of getting more beads, but we found none. We did find the following in no regular positions: seven curved flint knives, very sharp; twenty-six arrow-heads without notches; one large finely polished celt of greenstone; six groundhog jaws; deer and bear bones; nearly a peck of charred hickory-nuts. Fourteen whole pieces of pottery were uncovered, but the material was so poor and so soft none of them would hold together. We lifted fragments very carefully, but could not retain them in pieces larger than 2x3 inches.

Just beyond this ash-pit were two skeletons laid nearly side by side, heads to the south. Near the head of one was our third copper plate. This plate showed traces of cloth—the weaving, the fibre, etc.; but the cloth itself had long ago gone to dust. Around the neck of the other skeleton were eleven drilled wolf teeth. Two small shell ornaments, perforated, lay where his ears once were. In his mouth (mirabile dictu!) were fifty pearl beads, larger and more evenly perforated than the others. The skull of this person was saved entire. When the point was dug back sufficiently to reach the center, two well-preserved skeletons were taken out at about half way between the top and the bottom of the mound. At the exact center of the mound another skeleton with a bone ornament on his arm was found. It has two holes drilled through it. Over twenty discs of mica were found. A rough, ill-shaped altar was found on the east side, about the same distance from the edge where the good one on the west was placed; but no ashes accompanied it, and we did not attempt to save it. Indeed, this one was so irregular that measurements could not be obtained. Roughly it was 30x35 inches, 8 to 10 inches thick. The mound had seven layers; they were not brightly colored earths as some mounds are, but were dull colors. They ran:

Surface above.
Black soil, 1 foot.
Gravel, one foot.
Brown earth, 3 inches. (First three layers much disturbed on
Dull yellow, 3 inches. account of plowing the field.)
Black, 6 inches. Layers now showing better.
Sand, 8 inches. The sand was white, beautiful.
Black soil, with pebbles, 3 to 4 inches.
Red clay, burnt, 4 to 5 inches.
Gravel and clay base, 1 foot.
Surface of ground (bottom).

The exact center of the mound was filled with a mass of the purest ashes I ever saw. They were white as snow, soft, and must have been sifted or sorted very carefully. Ordinary ashes would contain charcoal flakes and other impurities. We took out over six bushels of this ashes. The mound opening attracted much attention. Some days we had over three hundred visitors. The farmers became so interested in the work that mounds were offered to me by the dozen. When I left Frankfort I had over thirty mounds promised to excavate. Had I not been nearly killed by the caving in of a mound, I should have continued digging all winter. I hope to be strong enough to return and continue the work in the spring.

WARREN K. MOOREHEAD.

Smithsonian Institution, January 23, 1889.

ON A COLLECTION OF FISHES FROM EAST TENNESSEE.

By Dr. James A. Henshall.

(Read June 4, 1889.)

Mr. Charles Dury, recently, while collecting insects in East Tennessee, collected a small lot of fishes, consisting of five species, two of which seem to be new to science.

The specimens were procured at Whiteside, Tennessee, a station on the Memphis and Charleston Railroad, from a small tributary of the Tennessee River, and are now in the museum of the Society. The fishes were in their spring, or breeding dresses, which were unusually and remarkably brilliant, due no doubt to the clear and pure water of the mountain stream in which they were taken. Following is a list of the collection :

Campostoma anomalum (Rafinesque). One example 2¾ inches in length. The specimen differs from the usual form of this widely-distributed species, in its more slender body, long caudal peduncle and deeply forked caudal fin.

The coloration differs also, in being silvery instead of brassy, with the usual black or dark mottling. Throat and belly rosy. No opercular spot; dorsal and anal fins plain, the usual dusky bar being absent.

Head 4½; depth 5. Teeth 4–4. Scales 6–51–5. D. 8. A. 7.

Chrosomus erythrogaster (Rafinesque). Three examples 2½ inches in length. Body fusiform, tapering regularly, little compressed. Mouth small, oblique, terminal. Lateral line extends from opercle to ventral fin.

Coloration: Brownish on top of head and back, shading into a black border extending from head to caudal fin. Mouth, lips and throat jet black. A broad, jet black band passing from mouth, through the eye and extending to caudal; under the dorsal fin it gives off a branch leading toward the anal fin. The space between the black bands, the entire belly, and the suborbital space are intense scarlet; fins more or less scarlet; opercle, silvery.

Head in length, 4½; depth, 4½. Teeth, 4–5. 90 scales along the lateral line. D. 7. A. 8.

ETHEOSTOMA DURYI, nov. sps. Five specimens, 3 male and 2 female; length from 2 to 3 inches. Body stout, rather elongate, somewhat compressed; back arched; profile regularly curved; snout obtuse; mouth small, horizontal, subterminal, maxillary, just reaching orbit. Caudal peduncle curving slightly upward; caudal fin emarginate. Lateral line almost complete, following curve of dorsal outline. Gill membranes broadly united. Fins large; dorsal fins high, and scarcely connected; first dorsal with longer base than second, but fin not so high; longest dorsal spine 1½ times in head. Cheeks, nape and opercles scaly. Eye, high up, as long as snout, and contained 3½ times in head. 14 scales between dorsal and head, crowded anteriorly. Premaxillary not protractile.

Coloration in alcohol: 8 or 9 quadrate blotches along dorsum; a dark, broad band along the lateral line, on which are ten well-defined quadrate blotches. Between the dark coloration of the dorsal and lateral lines is a lighter area of orange (probably) in life. Belly orange. A dark bar below the eye. The darker coloration is probably blue in life. First dorsal fin dark along the base, with horizontal or diagonal blotches, apparently orange in color, running up to top of fin, between the rays; second dorsal and anal with vertical orange stripes between the rays; pectoral and ventral fins plainer.

Head 4½; depth 4½. Scales, 5–52–8. D. XI., 11. A. II., 6.

ETHEOSTOMA FORMOSA, nov. sps. One example, 2½ inches long Body fusiform; back regularly curved, not elevated; head conical; mouth terminal, slightly oblique, moderate, maxillary reaching a little beyond front of orbit. Lateral line nearly complete, following curve of back. Gill membranes slightly connected; premaxillary not protractile; teeth on vomer; jaws well armed with teeth. Eye as long as snout, 4 in head. Dorsal fins separate, moderate; base of first dorsal longer than second, but fin not so high; longest spine of dorsal twice in head. Opercles and nape scaly; cheeks and breast naked.

Color in alcohol: 10 dark (blue?) bars or rings from dorsum to belly, those on latter half of body completely encircling it; lighter, or orange, interspaces; cheeks and throat light, probably orange in life; opercles darker. First dorsal with upper half dark (blue?), lower half lighter (orange?); second dorsal and anal fins mottled, probably blue and orange; pectoral and caudal plain; ventrals dark.

Head 3½; depth 4. Scales, 4–43–8. D. X., 13. A. II., 8.

COTTUS RICHARDSONI Agassiz. One example, 3 inches long. Body stout, tapering rapidly to caudal fin. Profile curved; vertex slightly

depressed; no interocular groove; sharp, slightly-hooked preopercular spine, with two smaller concealed spines below; skin entirely smooth; lateral line absent only on caudal peduncle; isthmus broad, with gill-membranes fully united. Pectoral fin large, reaching to second dorsal.

Coloration: Olivaceous with dark blotches and maculations; fins barred and speckled.

Head 3½; depth 5. D. VII, 17. A. 13. V. I., 4.

REMARKS UPON SEDIMENTATION IN THE CINCINNATI GROUP.

(Read June 4, 1889.)

By Prof. Joseph F. James, M. S., United States Geological Survey, Washington, D. C.

I have in a former article* referred to the probable presence of beaches in the rocks of the Cincinnati Group. The evidence of the beaches consists in the presence of mud cracks, trails and burrows, such as could only have been made upon an exposed surface, or at least one covered with a slight depth of water. These evidences are found at at least two horizons in the exposures at Cincinnati, one near low-water in the Ohio River, and the other about three hundred feet higher. There is evidence of a third beach at a still greater elevation; probably two hundred feet higher up. This is exposed in several cuttings on Four-mile Creek near Oxford, Ohio, about forty miles north of Cincinnati. In one of these places there is a layer containing what appear to be rain-drop impressions. The layer was found in 1887 by Mr. N. W. Perry, who called my attention to it. The impressions are large and distinct, some of them measuring a fourth of an inch in diameter. The rock is a hard limestone, made up of finely comminuted material, and occasionally containing the remains of brachiopods. In the same layer are also found various markings referred to inorganic causes, such as rill-marks, or marks made by running water.

At another point, several miles away, but along the same stream, are found well-defined ripple-marks, in some cases having considerable extent. These, it is true, may have been, and probably were, made under water, but the rain-drop impressions must have been made on an exposed surface. The accompanying plate† illustrates one of the most characteristic specimens of rock with these impressions.

Dr. Newberry, in an article upon "Circles of Deposition in American Sedimentary Rocks,"‡ and also in volume one "Geology" of the

*Science, Vol. V., p. 231, 1885.

† This will appear in a later number.—Editor.

‡Am. Asso. Ad. Sci. Proc., Vol. XXII., part 2, pp. 185–196, 1873.

Geological Survey of Ohio, refers to the various sorts of sediment forming the strata of the Lower and Upper Silurian and the Devonian. He says that the Potsdam sandstone, for example, was laid down upon a beach, and is "the first product of the invasion of the Eozoic continent by the ancient ocean."* That the Calciferous sand-rock, lying next above, may be considered as formed of sediments thrown down in deeper water, and as the second product of the invasion by the sea; that the Trenton, next above, has resulted from the accumulation of organic matter at the bottom of a great ocean; and that finally the Hudson River Group, including the Cincinnati rocks, represents an epoch of retreating and shallowing seas and of a rising continent.

Everything that is known of the organic remains from the various formations points to the truth of this idea. The evidence of the inorganic remains testifies in a similar way. The presence of beaches at two and probably three horizons in the Cincinnati Group indicates two or three periods of elevation and subsequent depression. Elevation enough to bring the forming rocks to the surface for a sufficient length of time to allow of the formation and preservation of tracks, trails, etc., and depression enough to permit the laying down, in one case, of three hundred feet of shales and limestones, and in the other of an additional two hundred feet or more.

It is interesting to note, as was also pointed out by Dr. Newberry, that a cycle of events occurred in the Upper Silurian similar to that of the Lower. The Oneida conglomerate and the Medina sandstone correspond to the Potsdam sandstone, the Clinton to the Calciferous, the Niagara to the Trenton and the Lower Helderberg to the Hudson Group, or the Lorraine shales. In addition, however, there was the Salina, or Onondaga Salt Group, which as T. Sterry Hunt suggests, probably resulted from the evaporation of the sea-water from shallow basins partly enclosed by land. It would be interesting to know whether, in addition to the similarity of deposits of sediment, the Lower Helderberg Group will present evidences of successive beaches at several horizons, such as have been shown to exist in the Cincinnati Group. We know that in New York there are several successive beds characterized by more or less distinct faunas, and these certainly indicate varying conditions of deposit. Furthermore, inasmuch as the Hamilton Group closes a circle of deposition during the Devonian period, might we not look for similar oscillations of level

*Geol. of Ohio, Vol. I., p. 58.

there? In the Carboniferous period a fourth circle of deposition is found, and here, as shown by many successive layers of coal, sandstone and limestone, can be noted more frequent oscillations than have as yet been recorded from any of the older periods.

In the report of Prof. N. S. Shaler on the "Investigations of the Kentucky Geological Survey in 1873-'74 and '75," is an extended discussion of the Cincinnati axis. In this the origin of the sediment forming the rocks of the Cincinnati Group is considered. He states as the result of this investigation his conclusion that some of the beds of the Cincinnati Group were formed in shallow water, and that this water was swept by strong currents. His general conclusion is that "the occurrence of salt deposits at one level, pebbles at a point some hundred feet or more higher, of broken shells at yet another hundred feet up in the section, and finally of salt deposits again in the Bluegrass limestone (which forms the summit of the Cincinnati Group), gives us fair reason to conclude that this series of deposits was formed in a region which was balanced near the top of the ancient seas."*

It is thus seen that Prof. Shaler long ago came to the same conclusion as that announced by the writer in 1884.† It is but fair, however, to state that the conclusions of Professor Shaler were unknown to the writer until recently, and that his statement, though made eight or nine years subsequent to that of Professor Shaler, was entirely independent of any observations by others. Professor Shaler's conclusions were reached through a study of conditions of sedimentary deposit; my own through a study of the trails, burrows and inorganic markings found in the rocks.

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*Second Geological Survey of Kentucky, new series, Vol. III., p. 141.

†See this JOURNAL, Vol. VII. p. 93, October, 1884.

LIST OF PROCEEDINGS OF SCIENTIFIC SOCIETIES WANTED TO COMPLETE SETS IN THE LIBRARY OF THE CINCINNATI SOCIETY OF NATURAL HISTORY.

The Society will be thankful to receive any of the publications mentioned, and in exchange will furnish lacking parts of its JOURNAL, excepting Vols. I., II., III. (out of print):

Albany Institute.
 Transactions, Vol. II.

American Academy of Arts and Sciences.
 Memoirs, Vols. I. to XI.

American Association for the Advancement of Science.
 Proceedings, Vols. XIII., XV., XXI., XXVI.

American Geographical Society Journal.
 Vols. I., VI., VIII., IX., XIV, XV.

American Antiquarian.
 Vol. I., Nos. 2 and 3, Vol. II., No. 2, Vol. III., No. 2.

American Journal of Science.
 First Series, Vols. XI., XXII., XXXIX.
 Second Series, Vols. XXV., XXVIII., XLIII. to L.
 Third Series, Vols. I. to XII.

American Philosophical Society.
 Proceedings, Vols. I. to V.
 Transactions.
 First Series, Vol. II. to end of Series.
 New Series, Vols. I., II., IV., VII. to end.

American Monthly Microscopical Journal.
 Vol. II., Nos. 11 and 12; Vol. III., Nos. 4, 5, 10 and 12; Vol. IV., Nos. 9, 10, 11 and 12; Vol. V., No. 1.

Academy of Natural Sciences.
 Proceedings, Vols. V., VI.

Academia Nacional de Ciencias.
 Tome I. to V.

Augsburg Naturhistorischen Verein.
 Bericht Nos. 1 to 20.

Academie des Sciences, Inscriptions et Belles-lettres.
Transactions—all up to Series 8, Vol. VIII.
Societe Malacologique de Belgique.
Annales, Vols. I. to XII.
Proces Verbaux, Vols. I. to IX.
Boston Society of Natural History.
Proceedings, Vols. III. to X., XIV. to XVIII., XIX.
Bern Naturfirschende Gesellschaft.
All previous to 1878.
Naturwissenschaftlichen Verein zu Bremen.
Abhandlungen, Vols. I. to VII.; VII., Nos. 1, 2, 4.
Botanical Society, Edinburgh.
Transactions, Vols. II., III., VI. to X., XI. to XIII.
Botanical Gazette.
Vols. I. to X.
Botanischen Verein der Provinz Brandenburg.
Publications previous to 1879.
Bristol Naturalists' Society.
Proceedings, Vol. I., Part I.
Cassel Verein fur Naturkunde.
Bericht, 1 to 28.
Canadian Entomologist.
Vols. I. to III.
California Academy of Sciences.
Proceedings Vols. II., III.; IV., Part 6 to close of volume.
Cambridge Museum of Comparative Zoology.
Bulletin, Vols. I., II.
Memoirs, all lacking except Vol. X., No. 3.
Canadian Institute.
Proceedings, Vol. I., Nos. 1, 2; Vol. II., Nos. 1, 4.
Canadian Journal.
Vols. I. to XIII; Vol. XIII., Nos. 7 to 12; Vol. XIV., Nos. 7 to 12; Vol. XV., Nos. 5, 9 to 12.
Colorado Scientific Society.
Proceedings, Vol. I.; Vol. II., Part I.
Journal of Comparative Medicine and Surgery.
Vols. I. to VII.
Deutschen Wissenschaftlichen Verein zu Santiago.
Verhandlungen, Heft I., II.

Dennison University.
Bulletin of the Laboratories, Vols. I., II., III.
Johns Hopkins University.
University Circulars Nos. 1 to 11, 14, 16, 18 to 23, 25, 26, 27, 33, 34, 60, 61, 62.
Kansas Academy of Science.
Transactions, Vols. I. to VIII., and all publications subsequent to Vol. IX.
Kaiser Königlichen Geologischen Reichsanstalt.
Verhandlungen—publications previous to 1878.
Kongl. Vetenkaps Akademiens.
Ofversigt—previous to 1882.
Kiew Societie des Naturalistes.
Memoirs, Vols. I. to VII.
Leipzig Verein fur Erdkunde.
Mittheilungen, previous to 1884.
Linnean Society, New South Wales.
Proceedings, First Series, Vols. I. to VII.
Manchester Literary and Philosophical Society.
Memoirs, previous to Third Series, Vol. VIII.
Proceedings, Vols. I. to XV.
Museu Nacional, Rio de Janeiro.
Archives, Vols. I. to V.
Manitoba Historical and Scientific Society.
Publications, previous to 1887.
Natural History Society of Glasgow.
Proceedings, First Series, Vols. I. to V.
Nova Scotian Institute of Natural Sciences.
Proceedings, Vols. I. to IV.; Vol. V., Parts 1, 4.
New York State Museum.
Annual Reports, Nos. 1, 2, 4, 5, 6, 9 to 14, 17, 35.
Bulletin, Vol. I., No. 1.
Oberhessichen Gessellschaft fur Natur- und Heilkunde.
Bericht, Nos. 1 to 8, 10 to 18.
Ontario Entomological Society.
Reports previous to 1882.
Philosophical Society, Washington.
Bulletin, Vols. I. to VIII.
Royal Society, Edinburgh.
Proceedings, Vols. I. to VIII.

Royal Physical Society, Edinburgh.
Proceedings, Vols. I. to V.
Royal Society of New South Wales.
Journal and Proceedings, Vols. I. to X.
Royal Microscopical Society.
First Series, all except Vol. II., Nos. 5, 6, 7, and Vol. III.
Royal Geological Society of Cornwall.
Vols. I. to X.; Vol. XI., Parts I., II.
School of Mines Quarterly.
Vol. I.
Societa Toscana di Scienza Naturali.
Memorie, Vols. I. to III.
Processi Verbali, Vol. I.
Societa Africana d'Italia.
Anno I. to V.
Societatum Litterae.
First Year.
Monatliche Mittheilungen.
First to Fifth Year.
Societe Zoologique de France.
Bulletin, Vols. I. to III.; Vol. XIII., Nos. 1, 11, 12; Vol. XIV., Nos. 3 to 12.
Torrey Botanical Club.
Bulletin, Vols. I. to VIII.
University of Minnesota.
Experiment Station Bulletin, Nos. 1, 2.

EXPLANATION OF PLATES—PLATE I.

A. Myriostoma coliforme, Dicks.

B. Geaster limbatus, Fr.

2. Before the outer peridium has opened.
3. Outer peridium open and expanded; inner peridium pedicellate, constricted below.
4. Diagrammatic section of the inner peridium exhibiting form and size of the columella and the shape and origin of the threads of the capillitium.
5. Threads and spores much magnified.

C. Geaster saccatus, Fr.

6. Before the outer peridium has opened.
7. Outer peridium open and expanded, saccate; inner peridium sessile.
8. Diagrammatic section of the inner peridium, exhibiting the columella and capillitium.

PLATE II.

A. Mitremyces lutescens, Schw.

1. Before the outer peridium has burst.
2. Showing the sacculus suspended from the mouth.
3. Section of the inner and outer peridium before the latter has opened.
4. Inner peridium exhibiting the segments of the outer peridium about the base and the stellate mouth.
5. One half of the inner peridium cut away showing the suspended sacculus.
6. Diagrammatic section of the inner peridium exhibiting the origin, branching and interweaving of the threads. The illustration applies also to Astræus.
7. Threads and spores much magnified.

B. Astræus hygrometricus, Pers.

8. Before the outer peridium has opened.
9. Outer peridium expanded, the segments reflexed, moist.
10. The segments unfolded, dry.
11. Threads and spores much magnified.

N. B. The diagrammatic section would be similar to that of Mitremyces.

EXPLANATION OF PLATE III.

1. Paludomus lacunoides n. sp.
1a. Same.
1b. Same, young shell.
1c. Same, young shell.
2. Alycaeus sp?
2a. Same.
2b. Same.
3. Trochomorpha Kusana, n. sp.
3a. Same.
3b. Same, enlarged view of nucleus.
4. Clausilia (Euphædusa) dohertyi, Boettger, n. sp.
4a. Same.
4b. Same, apex enlarged.
4c. Same, aperture enlarged.

THE JOURNAL

OF THE

Cincinnati Society of Natural History

Vol. XII. CINCINNATI, OCTOBER, 1889. Nos. 2 & 3.

PROCEEDINGS.

BUSINESS MEETING, *April* 2, 1889.

President Skinner in the chair.

The minutes of the January business meeting were read and approved.

The following were nominated for active membership: Ketaro Shirayamadani, Jas. B. Daniels, T. B. Estep, Dr. L. S. Colter, Dr. A. C. Kemper, Rudolph Wurlitzer, Chas. Pettibone.

Mrs. Harry Rosenbaum was elected to active membership.

The minutes of the Executive Board for January, February and March, were read, corrected and approved.

In the absence of Mr. Wright, the Treasurer's report was read by Mr. Skinner.

A committee consisting of D. L. James, Dr. A. J. Howe and Dr. O. D. Norton, was appointed by the President to audit the Treasurer's accounts.

President Skinner made a brief verbal report on the work of the Society during the past year, and its prospects for the future, especially in connection with the securing of a building site in Eden Park.

The Society proceeded to the election of officers, Dr. Howe and Mr. D. L. James acting as tellers.

The following officers were then elected:

President, Mr. Wm. Hubbell Fisher.
First Vice-President, Mr. Davis L. James
Second Vice-President, Dr. A. T. Keckeler.
Secretary, Dr. James A. Henshall.
Treasurer, Mr. S. E. Wright.
Librarian, Miss Amanda Frank.

Members of the Executive Board: Prof. Geo. W. Harper, Dr. W. S. Christopher, Mr. J. Ralston Skinner, Mr. A. D. Smith.

Curators:

Geology, E. O. Ulrich.
Entomology, Chas. Dury.
Botany, Miss Nettie Fillmore.
Zoology, Osteology, Anthropology, Dr. A. J. Howe.
Photography, Geo. Bullock.
Microscopy, Geo. B. Twitchell.
Meteorology, Serg. P. T. Jenkins.
Physics and Chemistry, Dr. Mary Osborn.

Mr. Wm. P. Anderson was elected Trustee.

The committee appointed to prepare a memorial of Mr. U. P. James, presented their report, which was referred to the Publishing Committee, and ordered to be spread in full upon the minutes of the Society.

The amendment to Article VI., Section 2, of the Constitution, was read for the first vote. A rising vote resulted in 11 in favor of the amendment, and 9 against. The Chair declared the amendment lost.

Donations: From Mrs. Dr. Henshall, Oriole nest; from C. P. Yeatman, skull, egg and portion of skin of Orinoco Alligator; from Dr. C. H. Ware, Collection of Minerals; from Arthur Whitney, four specimens of Limulus polyphemus; from Dr. B. M. Ricketts, four volumes of Journal of Royal Microscopical Society, Reports of Ohio Meteorological Bureau and miscellaneous pamphlets; from Prof. Jos. F. James, miscellaneous books and pamphlets.

Scientific Meeting, *May* 7, 1889.

President Fisher in the chair.

The minutes of the March meeting were read and approved.

Mr. Fisher read a paper on "The Recent Oyster War and its Economic Aspects."

The following were proposed for active membership: Miss Louise Armstrong, Miss Baldwin, Miss Adeline Stubbs, Mrs. Geo. W. Harper, Miss Margaret Burnet, Edwin F. Smith, Harry T. Stevenson and L. S. Fechheimer.

The following were elected to active membership: Ketaro Shirayamadani, Jas. B. Daniels, T. B. Estep, Dr. L. S. Colter, Dr. A. C. Kemper, Rudolph Wurlitzer and Chas. Pettibone.

Dr. A. T. Keckeler moved an amendment to Article VI., Section 2, of the Constitution, being the same amendment that was voted upon and lost at the meeting of April 2, 1889.

The committee appointed to audit the accounts of the Treasurer reported progress.

Donations: From E. O. Hurd, mounted specimen of Dusky Duck; from Robert Clarke, two specimens of Fossil Fish; from O. P. Hamer, miscellaneous minerals; from C. G. Curtis, Slide of Diatoms; from W. H. Wyman, miscellaneous minerals.

SCIENTIFIC MEETING, *June* 4, 1889.

President Fisher in the chair.

The minutes of the May meeting were read and approved.

A paper on "Sedimentation in the Cincinnati Group," was read by Mr. Davis L. James for the author, Prof. Jos. F. James.

Remarks in corroboration and support of the views presented in this paper, were made by Nelson W. Perry.

Dr. A. N. Ellis read a paper on "The Influence of the Trade Winds on the Health of the World."

Dr. Henshall read by title, a paper "On a Collection of Fishes from East Tennessee," and gave an oral account of the work of the U. S. Fish Commission in Florida, during the past winter.

The following were elected to active membership: Mrs. Geo. W. Harper, Miss Margaret Burnet, Miss Louise Armstrong, Miss Baldwin, Miss Adeline Stubbs, H. T. Stevenson, Edwin F. Smith and L. S. Fechheimer.

The amendment to Section 2, Article VI., of the Constitution, was presented to the Society for action, and on motion, was laid upon the table.

Dr. Henshall moved that a committee of five be appointed by the President (one of whom shall be a member of the Photographic Section), to revise the Constitution and By-Laws of the Society.

Donations: From Martin Jones, mounted specimen of Green Parrot; from Zoological Garden, Skeleton of Manatee; from Davis L. James, memorial and portrait of Mr. U. P. James; from Mrs. Dr. Henshall, stone pestle; from Herbert Jenney, one pair Walrus Tusks, two teeth of Sperm Whale; from U. S. National Museum, two Femora, two Tibiæ and two Humeri of Great Auk; from Miss Julia A. Keely, collection of shells, fossils and relics; from Chas. Dury, a number of specimens (five species) of small fishes from East Tennessee; from unknown donor, Atlas of Human

Anatomy—parts, Jasper's Birds of North America—parts, Plates to Leidy's Fresh Water Rhizopods.

Business Meeting, *July* 2, 1889.

President Wm. Hubbell Fisher in the chair.

A quorum not being present, the entire business programme was omitted, and the reading of scientific papers was called for.

Mr. Wm. H. Knight read a paper on "Variable Stars."

On the conclusion of Mr. Knight's paper, a quorum being present, the Society proceeded with the business of the evening.

The minutes of the April business meeting were read and approved.

Owing to the absence of the minute-book of the Executive Board, the reading of the proceedings of the Board was omitted.

The following were proposed for active membership: B. Wolfe, F. A. Autenheimer, Chas. J. Herrick.

Dr. B. M. Ricketts read a paper on Photo-Micrography, illustrating the subject by lantern siides and apparatus.

Dr. O. D. Norton made remarks on the Albatross and Flying Fish, presenting the Society with a mounted specimen of the latter and head of the former. On motion, the Society adjourned.

Donations: From Dr. O. D. Norton, mounted specimen of Flying Fish, and mounted head of Albatross; from Zoological Garden, eggs of Emu and Buzzard.

Scientific Meeting, *August* 6, 1889.

President Fisher in the chair.

The minutes of the June scientific meeting were read and approved.

Mr. H. P. Smith read a paper entitled the Ancestry of Dogs, which elicited remarks from Dr. B. M. Ricketts, Mr. D. L. James and Col. Abert.

Mr. Alfred Knight presented a paper on "Fort Hill Mound."

A ballot for election of members showed but eight members present; nine being necessary for a quorum, the names were held over until the next meeting.

Donations were announced, and on motion the Society adjourned.

Donations: From Mr. W. T. Garratt, model of birch canoe from Yukon River, specimens of Pyrethum cinerariæfolium; from Walter Crane, jar coated with coral; from Mrs. W. H. Clement, two specimens of Coquina, one of conglomerate rock.

SCIENTIFIC MEETING, *September* 3, 1889.

Vice-President Davis L. James in the chair.

Mr. Warren K. Moorehead read a paper on "Fort Ancient," illustrating by photographs the various portions described.

The discussion of Mr. Moorehead's paper was participated in by Major L. M. Hosea, Dr. Norton and others.

A paper on North American Squirrels was read by Mr. Chas. Dury. Several fine specimens were shown.

Dr. F. W. Langdon and others participated in the discussion on Mr. Dury's paper.

Dr. Langdon read portions of his paper on the "Occurrence in Large Numbers of Seventeen Species of Birds," which was presented for publication.

Mr. James read by title a paper on "Devonian Plants of Ohio," by Prof. J. S. Newberry, and announced that others had been promised.

The following were elected to active membership: Prof. C. L. Herrick, Jos. R. Monfort, B. Wolfe, F. A. Autenheimer, Chas. J. Herrick, Dr. M. Cassat.

Donations were announced, and the Society adjourned.

Donations: From D. L. James, two specimens Belostoma americana; from Dr. A. E. Heighway, two fossil Vertebræ, one specimen of *Calamites*; from C. G. Lloyd, "Drugs and Medicines of North America;" from C., C., C. & I. R. R. Co., through Mr. Osborne, portion of lower jaw and tooth of Mastodon; from Dr. A. B. Carnahan, Indian pipes and spear points.

DEVONIAN PLANTS FROM OHIO.

By J. S. Newberry.

(Read by title September 2 1889.)

Among the materials prepared for the third volume of the Palæontology of Ohio, are drawings and descriptions of many species of fossil plants and fossil fishes which well deserved publication. As there seemed no probability that another volume of Palæontology would be published by the State, I have added to the descriptions of the remarkable fossil fishes found in Ohio, notes on those obtained elsewhere, and have formed from all a Monograph of the Fossil Fishes of the Palæozoic Rocks of North America, which has just been published by the United States Geological Survey.

Among the fossil plants of which I have drawings and notes, there are a few from the Devonian rocks that are of special interest from their antiquity, their botanical character and mode of occurrence. Of these I herewith present figures and descriptions. I have also a number of new species of plants from the Coal Measures, of which drawings and descriptions have been prepared, and which will, perhaps, be made the subject of another memoir.

The land plants of the Devonian system have naturally excited much curiosity, as they form, if not the beginnings, at least the first considerable development of terrestrial vegetation, and it was hoped they would do much to illustrate the progress of plant life on the globe, and would throw light on the question of how the higher forms were evolved from the lower. It must be confessed, however, that while they have given us fascinating glimpses of the head of the column of terrestrial vegetation that has marched across the earth's stage during the different geological ages, they have given us little insight into the spirit of the movement. They have shown us an important phase of plant evolution, but have helped us little in our efforts to understand the cause and *modus* of this incessant advance from the simple to the more complex, the general to the special.

It is only within a few years that any considerable number of fossil plants have been obtained from the Devonian rocks. Unger

gives in his illustrations of the vegetation of the different ages, one picture of the Devonian flora. This represents dry land bearing large trees of *Lepidodendron* and marshes filled with the imaginary *Stigmaria*, now demonstrated to be nothing else than stumps and roots of *Sigillaria* and *Lepidodendron;* the trunks and branches having decayed and disappeared, the roots and rootlets being preserved in clay or carbonaceous marsh mud.

Later Sir William Dawson added greatly to our knowledge of the Devonian flora by the study of the large collection of fossil plants made near St. John's, New Brunswick, and at Gaspé, Canada. The plant bearing beds of these localities belong mostly to the upper part of the Devonian system, but are clearly older than the Lower Carboniferous rocks with which they are associated. Sir William Dawson has now described nearly two hundred species of Devonian plants, and has shown that the botanical character of the Devonian flora is essentially the same as that of the Carboniferous system, as it includes *Lepidodendron*, *Sigillaria*, *Cordaites*, *Sphenophyllum*, *Calamites* and many ferns, mostly of Carboniferous genera.

The fossil plants from New York, described by Sir William Dawson, Hall and Vanuxem, are from the Chemung or Catskill rocks, which have been heretofore considered as the uppermost portion of the Devonian system, but in my judgment should rather be regarded as the basal members of the Carboniferous. The same is true of the fossil plants from Perry, Maine, first brought to the notice of geologists by Prof. William B. Rogers, at the Newport meeting of the American Association in 1860, and afterward described by Sir William Dawson (Journal Geological Society of London, 1863, page 450).

The plants now described from the Corniferous limestone of Ohio, are from about the middle of the Devonian system, having the Oriskany below and the Hamilton above. They are all from the Delaware limestone, the upper division of the Corniferous. It has been thought by some that this should be regarded as Hamilton rather than Corniferous, but as I have shown in my discussion of this subject, in the Geological Report of Ohio, Vol. III., p. 11, the testimony of the fossils contained in it is opposed to this conclusion; nearly all being found in the white or Sandusky limestone below. The Delaware limestone is much darker and more earthy than the lower division of the Corniferous, and it is evident that it

was deposited in shallower water when the land was nearer and the land-wash more abundant. The shallowing and narrowing of the Corniferous sea which produced this difference in the sediments deposited in Central Ohio, was perhaps somewhat sudden, but the change was not sufficiently great to destroy any considerable number of the mollusks which inhabited this ocean or to bring in any new fauna. A little later the water became much shallower, and was so loaded with sediment, that the marine life was wholly changed. The corals and mollusks all disappeared, and the Huron shale, deposited in this epoch, is remarkably barren of life. It contains; however, the remains of great fishes peculiar to itself, and what were floating logs of Corniferous trees of large size. Rather strangely these are about the only traces of land vegetation we find in the Huron shale: the carbonaceous matter, which composes one tenth or more of the mass, having probably been derived from Algæ. Impressions of sea-weeds are found in great numbers on some of the layers of the shale, but it has seemed to me that the diffused carbon was probably in large part derived from minute if not microscopic forms of aquatic vegetation.

Caulopteris antiqua, Newb.

Plate IV.

Stem three to four inches in diameter, marked with large, spirally arranged and separated leaf scars: scars about one and one-half inches long by one inch wide, regularly arched above, the outline marked by a raised rim, below horizontally truncated. The surface of the leaf scars is somewhat irregularly pitted and striated.

The only specimen of this plant known is a cast of a portion of a trunk about eighteen inches in length by three and a half to four inches wide. This bears on the exposed side twenty-two large leaf scars, with the bases of some of the fronds still attached to several of them. Between these scars the trunk is somewhat furrowed. These scars are not perfectly defined in this specimen, as the foot stalks of the fronds were apparently adherent to all of them when the specimen was fossilized. In the splitting of the rock, those portions of the leaf stems which projected into the limestone above the fossil were broken away, leaving an irregular fracture at the base of each leaf scar, so that its lower outline, and that portion of the surface which would naturally carry the vascular impressions, is concealed. The scars are distinctly separated from

each other both laterally and vertically. Probably if their complete outlines could be traced, it would be found that each one was obovate in form, with the lower extremity truncated.

The structure of this interesting fern-stem is not visible, as the specimen found is only a cast, covered with a carbonaceous coating, which retains the general aspects of the external surface.

The figure now given represents fairly well the general appearance of about half the specimen. By referring to this, the most superficial observer will be satisfied that this is a tree-fern, and the botanist will discover that it has essentially the structure of many tree-ferns of the present day. It differs from any known species of *Caulopteris*, but evidently belongs to the same group with *C. Lockwoodi*, from the Chemung at Gilboa, N. Y., and *C. Peachii*, from the Upper Devonian of Scotland; the latter described by Salter in the Journal of the Geological Society of London, for 1858; the former by Professor Dawson, in the same Journal of August, 1871. From both these, however, it is easily distinguishable; in *C. Lockwoodi* the trunk is much smaller, the leaf scars larger, broader and more crowded: in *C. Peachii* they are more remote, much smaller and more transverse. The specimen before us is much the best example of a tree-fern yet found in the Devonian rocks. It was obtained from the quarries in the Corniferous limestone at Sandusky. Special interest attaches to it, not only on account of its botanical character, but from the fact that it must have floated out to sea from some not very distant land, and with *Caulopteris peregrina*, N., *Sphenophyllum vetustum*, N., and *Lepidodendron Gaspianum*, *Dwn*, represents a beautiful and highly organized flora, which grew on the land bordering the Corniferous sea, and hence dating from the middle of the Devonian age.

In looking over the indications which geology gives us of the topography of our continent in Devonian times, we see that the interior basin was occupied by an open sea, which was bounded on the east by the Blue Ridge, on the northeast and north by the Adirondacks, the Canadian Highlands and the Archæan area south of Lake Superior. No part of this shore was less than three hundred miles distant from the locality where these plants were found, and it is therefore extremely improbable that several species of land plants should be carried so far, and sunk in that little portion of the sea bottom now opened by the Sandusky and Delaware quarries. It seems indispensable that we should find some

land surface nearer than the far distant shores of the Continent. This we are able to locate in the Silurian areas of Southern Ohio, Kentucky and Tennessee. In the first volume of the Report of the Geological Survey of Ohio, I have shown, as it seems to me by incontestable evidence, that these areas were islands in the Devonian sea, and as at Delaware and Sandusky a considerable number of fragments of land plants have been found in the Corniferous limestone, we are justified in supposing that our tree-ferns grew upon this land, and that its hills and valleys were adorned with a land flora perhaps as luxuriant and beautiful as any that has grown on the earth's surface since. The chances of any considerable portion of this flora being preserved, or at least discovered in the sediments of the adjacent sea, would seem to be quite small. These plants were doubtless uprooted by some river flood, or torn from the shore cliffs and hurled into the sea by the force of the wind, and tossed about on the waves until, becoming water-logged, they sank to the bottom. It is hardly possible that any considerable portion of the flora of the land from whence these specimens came, could have been preserved in this way, and we may safely infer, that with the larger arborescent forms there were many smaller and more delicate plants of which no traces now exist. We may also infer that since so many specimens of the vegetation of the Cincinnati island have been obtained at this early date, future years, in which the Corniferous limestone will be more extensively quarried, will add largely to our knowledge of this, so far as yet known, the earliest American terrestrial flora.

CAULOPTERIS PEREGRINA, Newb.

Plate V., Figs. 1, 2.

Trunk ten feet or more in length and at least six inches in diameter, external surface marked with a series of leaf scars, spirally arranged and separated longitudinally and vertically by distances generally less than their diameter. Interiorly the trunk is mainly composed of a matted mass of aerial roots.

The only specimens I have of this interesting plant, are too much worn and macerated, to show in perfection the character of the external markings. The leaf scars are rounded or transversely elliptical, and seem to have had much the character of those of *Protopteris*, as illustrated in the typical species *P. Sternbergii*, Corda (Beitrage, p. 77, Tab. XLVIII., fig. 1). Whether the central figure

of the scar is horseshoe-like, as in *Protopteris*, remains to be shown by better specimens than any yet found, but it is evident that the general character of the surface marking was essentially the same. The most interesting feature in the specimen before us is the trunk, which is composed of a vascular cylinder at the center, surrounded by a mass of adventitious roots which form a large part of its diameter. This structure is common enough in ferns of the present day,* and has been recognized in many fossil forms (*Psaronius*), but never before in any fern of the Devonian age.

Plate V., fig. 1, represents the exterior surface of the principal portion of a trunk several feet in length. Here we see the leaf scars distinctly indicated, and yet not sufficiently preserved to exhibit all details of their structure. It is evident that the trunk has been partially decorticated, the spaces between the leaf scars have been denuded and they themselves have been much injured by maceration. The cortical integuments remain, however, and conceal the interior mass of rootlets. Fibres are seen running into this from some of the leaf scars that have been most decomposed.

In fig. 2, a small portion of the lower part of the trunk is represented. Here the exterior coatings are entirely removed and we see nothing but a bundle of adventitious rootlets. Owing to the mode of preservation, in limestone, the microscopic details of the structure of the tissues are not preserved.

In the cabinet of the Wesleyan University, at Delaware, is one trunk apparently of this species which has a length of many feet, this, like the specimen before us, was taken from quarries in the Corniferous limestone at Delaware.

Dadoxylon Newberryi, Dawson.

Plate VI., figs. 3, 3a, 3b.

In the Huron shale on Huron River, in Erie County, about Delaware, and at various places in the southern part of Ohio, where this rock is exposed, masses of silicified coniferous wood are frequently met with. They are portions of the trunks of trees from a foot to two feet in diameter, often worn and rounded, apparently floated masses which have ultimately become water-soaked, have sunk to the bottom and been covered with the carbonaceous mud which now forms the great black shale of Central Ohio. From the number of such masses of wood, it would seem

**Dicksonia antarctica*, from Tasmania, etc.

that the land upon which the trees grew, was not very distant, and by following the outcrops of the shale westward, in Highland County, we find it thinning and coming to an edge on the shore of what was evidently a land area which once extended from Champaign County, southward, to Central Kentucky.

Some years since I sent specimens of these silicified trunks to Sir William Dawson, of Montreal, who was then giving special attention to the Devonian flora, and had described from microscopic examination several kinds of Devonian coniferous woods. He pronounced the wood from the Huron shale to be a species of *Dadoxylon*, new to science, to which he was kind enough to attach my name. A short description of this was subsequently published in the Transactions of the Royal Society of England, from which I quote the following:

"*Dadoxylon Newberryi*, Dawson. Cells of smaller diameter than in *D. Ouangondianum*; areoles in two and three rows, not quite contiguous; central pore oval, oblique; medullary rays very numerous and unequal, cells in one or two series, and sometimes as many as eighteen series of cells superimposed."

The specimens on which the above description was based were somewhat imperfect, the wood having been partially decayed before silification. In order to secure a more complete description I have recently given specimens of this fossil wood to my friend, P. H. Dudley, of New York, and he has kindly returned to me the following notes upon them:

"The specimens of silicified wood from the Huron shale, which you submitted to me for examination, present under the microscope the following characters."

Transverse Section.—Wood cells principally quadrangular, largest diameter four to five hundredths of a mm.; thickness of cell walls, one hundredth of a mm., and very uniform for the entire layers of growth which are wide, limits not conspicuous; medullary rays in longitudinal sections very abundant.

Radial Section.—The length of the cells of the medullary ray four to five times their diameter, cell walls oblique; areolation of cell walls in distinct groups, each group consisting of one, two or three longitudinal rows of areoles, the pores of which are elliptical and obliquely inclined; each areole is about one hundredth of a mm. in diameter; the groups of areola in the different cells are in radial rows; the cell wall between each group is often slightly contracted.

Tangential Section.—Medullary rays in single and double-width bands; simple bands have from one to twenty superimposed cells; double width bands have from six to thirty cells; nearly all the cells of the medullary rays contain globules of resinous matter.

SPHENOPHYLLUM VETUSTUM, n sp.

Plate VI., fig 1.

Stem much branched, flexuous, leaves crowded in irregular whorls, divergent, wedge-shaped, strongly nerved; nerves dichotomously forked; margins apparently fimbriate.

The imperfect state of preservation of the only specimen of this plant yet known makes it impossible to give a detailed and satisfactory description of it. The geological horizon of the rock from which it was obtained is, however, so low that all the plants found in it acquire special interest. The general aspect of the plant is that of the submerged branches of *Sphenophyllum erosum*, Brongt., in which the leaves are dissected and much crowded on the branches, but this bush-like appearance may be due to the skeletonizing of the leaves by maceration. The specimen before me, which consists of an impression and counterpart, was obtained by Prof. E. T. Nelson from the upper part of the Corniferous limestone, at Delaware, Ohio. As this is a marine deposit, abounding in shells and the remains of fishes, the conclusion that it is a land plant would be open to suspicion, if it were not evidently very unlike any known sea-weeds, and had not numerous other land plants been found with it. The stem is replaced by coaly matter which in its quantity proves that it had a woody structure, while sea-weeds, composed of cellular tissue only, have entirely disappeared, leaving nothing but an imprint with perhaps a stain of carbon.

We may then be quite sure that this is a land plant, and it resembles so closely *Sphenophyllum*, that I feel justified in referring it to that genus, which appears in the first group of land plants of which we have any knowledge.

As I have said with reference to the tree ferns found in the same locality with this and at Sandusky, there is a strong probability that this plant floated off from neighboring land occupying the position of the Cincinnati arch.

The type specimen is in the cabinet of Wesleyan University, Delaware, Ohio.

Lepidodendron gaspianum, Dawson.

Plate VI., fig. 2.

The specimen now figured is evidently a branch of *Lepidodendron*, and undistinguishable from Sir William Dawson's species. It would, however, be unwarranted to assert that it is the same, since the material for comparison is so meagre, but it is evident that if not the same, it is a closely allied species. The description of *Lepidodendron Gaspianum* was published in the *Canadian Naturalist and Geologist*, Vol. X., No. 1, p. 8 (1860), and was based on specimens said to occur in considerable abundance in the Devonian rocks of Gaspé, Canada.

The Gaspé series has a thickness of several thousand feet, and covers the entire interval between the Upper Silurian and the Lower Carboniferous. The plants are found from top to bottom of the section, and some of the beds—though all shore deposits—must be of the same age as our Middle Devonian Corniferous limestone. There is, therefore, no good reason why some of the fossils should not be of the same species, even though the localities are widely separated.

ON THE OCCURRENCE IN LARGE NUMBERS OF SEVENTEEN SPECIES OF BIRDS.

By F. W. Langdon, M.D.

(Contributed by request to the proceedings of the Linnæan Society of New York, at the meeting of February 1, 1889.)

[Read by abstract, Cincinnati Society of Natural History, Sept. 2, 1889.]

Mr. President and Members of the Society:

The following extracts from the writer's note-books are presented as bearing upon the special subject set for discussion at this meeting. Some of them have been already published in other connections as indicated; others have not heretofore been made public.

The writer sincerely regrets his inability to comply with the kind invitation of the Society, to be present in person and participate in the discussion. The A. O. U. check-list is followed in enumeration and nomenclature.

221. Fulica Americana, Gmel. American Coot. From the 25th to the 30th of October, 1874, I observed this species congregated in immense flocks at St. Mary's Reservoir (an artificial lake constructed for canal purposes in Mercer and Auglaize Counties, Ohio, about 130 miles north of Cincinnati).

Many acres of water were covered by these flocks for several days. The birds frequented open and exposed situations, merely flying far enough from the observer to keep generally out of gun-shot. The weather was warm and bright. A sudden "cold snap," producing a slight film of ice—about the 1st of November—caused their complete disappearance in a single night.

315. Ectopistes migratorius, Linn. Passenger Pigeon. One of the most notable occurrences of birds, numerically speaking, in the vicinity of Cincinnati, was the flight of wild pigeons which took place in the fall of 1865.

While I took no written notes of it at the time, I can distinctly recall the clouds of these birds that passed over the city and suburbs during the greater portion of three whole days, the air at times being literally darkened by them. Immense numbers were shot from the elevated ground surrounding the city, and scattered

flocks of two to three hundred individuals were present for a week, more or less, after the flight of the main body southward. One of these flocks it was my good fortune to observe on the ground in a piece of woodland, probably feeding on the fallen beechnuts, which were abundant that year.

Their feeding was very systematic. The birds presented a quite regular front of fifty or sixty yards in extent, and their ranks were from ten to twenty feet in depth. As this column progressed, it did so by the rear rank flying forward and alighting slightly in advance of the front row. This maneuver was continually repeated, so that they presented a constantly moving mass, apparently rolling forward like a smoke cloud. In this manner the tract of beechwood was effectually screened. Their movements were observed at our leisure—by myself and a companion—and having no gun at hand, the birds were not disturbed.

On another day of this same flight, at dusk, a flock numbering several hundred was flushed from a high, untrimmed hedge of osage orange, in the town of Madisonville, where they had evidently gone to roost for the night.

I do not know of the occurrence of the species here in such vast numbers since that year, but have noted flocks numbering from a dozen to fifty during the fall and winter, on several occasions, and have shot an occasional single bird.

367. Asio accipitrinus, Pall. Short-eared Owl. A remarkable "wave" of Short-eared Owls occurred in this vicinity in the fall of 1886.

Mr. Charles Dury, who called my attention to it, informed me that he mounted some eighteen or twenty specimens brought to him within a very few days. He also published the following account of the "Owl Wave.

Short-eared Owl.

Asio accipitrinus, (Pall.)

"In many years I have never known this owl to be so numerous in Southern Ohio. The first specimens were observed in November, 1866, and they remained in suitable localities until April, 1887. They lived in low flat meadows that were covered with long dry grasses and weeds. Near Glendale, during February, a young man saw a large white owl, which from his description seemed to be *Nyctea myctea* (Linn.), flying across a swampy field. He went home for a

gun, and returned to secure the bird, but he failed to get it. While crossing the field, which was inundated with water, numbers of short-eared owls flew up, until over thirty were counted in the air at one time. There was only one tree in the place, and on it all of the owls perched, presenting a very curious and unusual sight. All of the lower parts of the field where the owls were congregated was flooded by rains, driving the mice to patches of higher ground and giving the owls a chance to capture and devour them.

"One owl shot in this field contained three full-grown meadow mice. Of over twenty of these owls examined since November, 1886, up to May 1st (and excepting in one instance, November 26, when I took an imported sparrow from one), their food seemed to be exclusively mice."*

382. Conurus carolinensis, Linn. Carolina Paroquet.

"Mr. Joseph Settle tells me that Paroquets occurred in large numbers near Madisonville during the summers of 1837, '38 and '39. Few were seen in 1840, and none after that date."†

The Mr. Settle here mentioned, now deceased, was a prominent citizen and farmer, residing near Madisonville, and he described the birds to me as "green birds, in large flocks like blackbirds," and stated that they did much damage in the large apple orchard.

The date was distinctly fixed in his mind by the circumstance of moving from Plainville to Madisonville in 1840, and co incident with his removal he noticed the scarcity of the paroquets, as compared with the two or three preceding years.

420. Chordeiles virginianus, Gmel. Night Hawk.

"August 28, 1878: This species seen migrating in large numbers about dusk. They first appeared straggling along in twos and threes, but in a few moments twenty-five or thirty appeared in sight at once. About fifty seen in all, bearing steadily toward the southeast before an approaching storm."—Note book, F. W. L.

488. Corvus americanus, Aud. American Crow. A marked feature of avian life in the vicinity of Cincinnati, is the "crow-roost," situated in the suburb of Clifton, within three miles of the center of the city "as the crow flies." From this point their long lines of flight radiate like the spokes of a wheel over the surrounding country for many miles, starting at day-break and returning between four and five o'clock in the evening.

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*From the Journal of the Cincinnati Society of Natural History, July, 1887.

†Langdon, "Observations on Cincinnati Birds," Journal of the Cincinnati Society of Natural History, Vol. I., p. 115, 187[illegible].

I do not know that any attempt has ever been made to estimate the number of those that winter at this place, but there must be many thousands of them. Like its congener, the English Rook, the species seems to resort for many years to these fixed "roosts," or rookeries, but unlike the Rook, our species is, according to my observation at least, solitary in its breeding habits.

The Crow, while a common resident and breeding species in Southern Ohio, is present in far greater numbers from November to April. During this period the local ranks of the species are apparently reinforced by a migratory "wave" from the north, the region of the Ohio River being probably about the northern limit of the range of the species in winter.

This view was corroborated by the statement of my friend, the late Dr. Wheaton, well known for his numerous and valuable contributions to Ohio Ornithology, who informed me that the Crow was practically an unknown bird at Columbus in winter. About Cincinnati the species is abundant at that season, and when the ground is covered with snow they may be seen in immense numbers foraging along the water-line of our rivers and creeks.

495. Molothrus ater, Bodd. Cow-bird. Another species that congregates in large numbers here is the Cow-bird, which in July and August roosts by hundreds in the shade-trees about country residences and even in the streets of large towns I have observed them particularly abundant in the trees bordering the streets of Richmond, Indiana (population about 16,000), where their incessant din at nightfall and daybreak, and their abundant excrement, rendered them a nuisance only comparable to the European Sparrow. During the day they scatter over the surrounding fields in more or less compact flocks at this season, while in the spring and early summer these ornithological Mormons are only seen in groups composed of one male to four or five females. They doubtless seek the situations above noted for protection from the various enemies which would decimate their ranks in the woods or orchards.

While the bulk of the large flocks are "young of the year," there is a goodly sprinkling of mature birds; and whether these act as marshallers of the host—gathering them up one by one from their various foster-parents, is, so far as I know, an unsolved problem.

Their coming together, however, in this manner, as soon as able

to fly from their original guardians, is a striking verification of the old adage respecting "birds of a feather."

511*b*. Quiscalus quiscula æneus, Ridgw. Bronzed Grakle. "Sept. 11, 1877: Woods 'alive' with this species, especially frequenting beech trees and the ground beneath."—Extract from note-book of F. W. L., Madisonville.

The above is a common occurrence here at the season mentioned, when the species is much more numerously represented here than during the summer.

521. Loxia curvirostra minor, Brehm. American Crossbill.

522. Loxia leucoptera, Gmel. White-winged Crossbill. I am indebted to Mr. Charles Dury for a record of the abundance of these species here during the winter of 1868-'69. He observed them in December, and states that they were in large flocks, containing both species, in the proportion of two of the former to one of the latter species. He frequently observed them feeding on the seeds of the "Horse-weed" (*Ambrosia trifida*), which grows in abundance along our streams and in waste places

Both species have only been taken here since at rare intervals, and occurring in small numbers.

595. Habia ludoviciana, Linn. Rose-breasted Grosbeak. Amongst my notes on this species, which occurs rather sparingly here, though regularly, is one quoted from a letter from my friend, Mr. A. W. Butler, of Brookville, Indiana. "Rose-breasted Grosbeaks are here by the hundred." On writing Mr. Butler for further particulars he responds as follows: "Referring to my note-book I find that they appeared that year (1885), April 25, and were unusually common from May 7th to the middle of the month. I never saw so many Grosbeaks in my life before or since as I could find in one morning's walk that spring."

The year 1885, in which the above notes were made, was a "locust year" here for the *Cicada septemdecim*, but as the Cicadas did not emerge until the last week in May and the first week in June, that circumstance was evidently not accountable for the abundance of the birds. Neither was this species observed feeding on Cicadas when they did emerge.

611. Progne subis, Linn. Purple Martin. "August 14, 1877: Weather remarkably cool for several days past and the Martins show signs of migrating. The air to-night at 6:30 is full of them, all bearing in a southerly direction. This is about two weeks earlier than they usually leave."

"August 15, 1877, 7 A.M.: Martins still observed flying south." —Extracts from note-book of F. W. L, at Madisonville.

Following this are notes that no Martins were seen for several days, until September 7th and 8th, when a few were noted, apparently migrating. It may be noted in this connection that this species has diminished greatly in numbers here since the advent of the European Sparrow, which pre-empts nearly all the nesting boxes.

616. Clivicola riparia, Linn. Bank Swallow.

617. Stelgidopteryx serripennis, Aud. Rough-winged Swallow. Flocks numbering many hundreds and embracing both the above species are to be seen congregated at certain favored points along our rivers for several days during the latter part of August. These assemblies are evidently preparatory to the southern migration, which occurs from September 2d to 5th, in a body.

Their actions at these times are noticeably different from those observed during the summer. They circle in clouds over a limited area of water, while an audience of their fellows looks on from trees, shrubs and drift, bordering the stream. The evolutions are joined in from time to time by members of the audience, while individuals from the moving flock take their turn at the resting places.

These maneuvers, which seem entirely unconnected with the pursuit of food, are kept up at early morning, until the rising sun lifts the fog from the stream, when the birds scatter in all directions for the day, to meet and repeat the same performance at nightfall. After several days of this marshaling and gyrating the main body disappears, leaving only a few stragglers to represent the species for a week or more longer. My observations throughout the season lead me to conclude that the Bank Swallow outnumbers the Rough-winged species, in a ratio of at least three to one.

The thought has occurred to me that the above-mentioned assemblies may serve the purpose of a "training school," in which the inexperienced wings of the young of the year are put "in good form" for the long journey southward.

619. Ampelis cedrorum, Vieill. Cedar Waxwing. During the winter of 1865-'66, and for the two or three following seasons, this species was abundant at Madisonville, alighting in flocks of several hundred about residences. Their food appeared to consist chiefly of the berries of the red cedar. In the woods the wild

grape and hackberry fruit always attract them. On these various berries they gorge themselves until scarcely able to fly, and may be seen sitting quietly for long intervals, evidently awaiting the process of digestion. I have frequently taken from six to a dozen at a single discharge, as they sat in a compact flock after such a repast. They were known at that time locally as "ricebirds," and much shot for the table by country boys. Since the above-mentioned dates I have noted the species regularly, but not in flocks larger than from a dozen to fifty. It breeds here sparingly.

647. Helminthophila peregrina, Wils. Tennessee Warbler. In 1877 I found this species literally "abundant" at Madisonville, from September 8th to 30th; and stragglers were seen until October 15th."* They frequented every hedge, weed patch and thicket, as well as the tops of the lower timber.

Mr. Charles Dury also observed it in large numbers at Avondale, about five miles distant. His experience coincides with my own as to its comparative rarity previous to that year; and although a common species since, I have not seen such a "wave" as occurred that year.

766. Sialia sialis, Linn. Bluebird. "October 28, 1877: Flock of fifteen to twenty Bluebirds seen, probably migrants from north."—Note-book, F. W. L. The species is seldom seen here except in pairs or single families of five or six individuals.

*Langdon, "Observations on Cincinnati Birds," Journal of the Cincinnati Society of Natural History, October, 1878, Vol I., p. 112.

NORTH AMERICAN SCIURIDÆ OR SQUIRRELS.

By Chas. Dury.

(Read September 3, 1889.)

The *Sciuridæ* or squirrels of America north of Mexico, present one of the most interesting and variable families of our mammalian fauna. This variation of color and size in individuals of the same species, from the northern to the southern boundaries of the country, is extreme, and it is not surprising that Audubon and Bachman, in their North American Quadrupeds, published in 1849–'51 and '54, should have enumerated 38 species in this family, as many of them were described from very inadequate series of specimens to illustrate intergrading variation and geographical range. In 1857 Prof. Baird, with a much larger series of specimens, enumerates 38 species(1). Twenty years later Prof. J. A. Allen issued his Monograph of the American *Sciuridæ*(2). In this excellent work, which leaves little to be desired, Mr. Allen reduces the 38 species to 25, and the 12 species of *Sciuri* proper of Baird to five, with seven named varieties. In the preparation of this memoir, Mr. Allen examined over two thousand specimens, and his remarks on comparisons of anatomical and color peculiarities are very instructive and interesting.

Dr. Coues says, in his chapter on rodents, Standard Natural History, Vol. V.: "No animals are more inconstant than the squirrels in coloration. Color is nothing in a squirrel. Ignorance of the laws of color variation has caused nominal species without number to be introduced." In this connection I would urge upon this Society the importance of securing a large series, covering as wide a range as possible in this family.

The squirrels are the embodiment of grace and symmetry. Their movements are executed with the rapidity of lightning and the greatest precision. The Gray Squirrel (*S. Carolinensis leucotis*) is one of the most active of animals, when alarmed rushing through the tree-tops, making headlong leaps from bough to bough. It can get over the ground as fast as a man can run along it. The only species of squirrels I have ever met with in this locality were the

(1). Pacific R. R. Survey, Vol. VIII., p. 240.
(2). Hayden Survey, Vol. XI., p. 633.

"Flying Squirrel" (*Sciuropterus volucella* var *volucella*), "Northern Gray Squirrel" (*Sciurus carolinensis* var *leucotis*), "Fox Squirrel" (*Sciurus niger* var *ludovicianus*) and the "Ground Squirrel" (*Tamias striatus*).

The Gray Squirrel was the most abundant and lived in the higher forests. The Fox Squirrel was abundant along the lower wooded river bottoms. The Ground Squirrel was abundant everywhere, and could be seen running along the old rail fences.

Squirrel-hunting is a fascinating sport, but has become a lost art in this immediate vicinity, owing to the reduction, almost to the verge of extinction, in the numbers of the game. In former years the squirrel-hunter used a muzzle-loading rifle of small calibre, with the stock of wood extending to the muzzle. The charge of powder was taken from a horn and measured in a goose-quill, after which the round, leaden ball, incased in a greased patch, was rammed down with a slender hickory rod, firmly on to it. The old-timer disdained to hit his game anywhere except through the head, a feat that required great steadiness and skill. Along the Great Miami twenty-five years ago, a good shot, armed with a weapon such as the one described above, could kill as many squirrels as he could carry. I once hunted squirrels with an old hunter, near Miamitown, allowing him the first shot with his rifle, and in the event of his missing, I was at liberty to use my shot-gun. It is needless to say I very seldom got a squirrel. My companion, who wore a pair of home-spun pants with a blouse of bedticking, always went barefoot when squirrel-hunting. He was a typical old-timer, and had killed wagon-loads of squirrels, all shot through the head.

On one occasion, when crossing a plowed field, we came to an isolated hickory tree. In this tree five Gray Squirrels had congregated in its lofty top for nuts. As we approached, I remarked to my companion, "We are sure of all of those." His answer was, "I don't know about that," at the same time drawing a bead on one of their heads. When the rifle cracked, the victim fell down, minus the top of his head, but the others jumped from the tree-top, striking the plowed ground with great force, and ran away unharmed. On another occasion, near Enterprise, Fla., three others and myself surrounded a huge pine tree in which one of the large Southern Fox Squirrels had taken refuge. As there was no hole in the tree, we felt sure of this specimen; but when one shot was fired, the squirrel leaped from the tree-top, landing with great violence on

the hard ground, and bounding into the air like a rubber ball, it ran away to its bed tree, leaving the hunters standing around looking after it in blank amazement.

The Fox Squirrel is not nearly so active as the Gray, and resorts to different tactics. It crouches down flat on a thick limb, and no matter to which side of the tree the hunter goes, the squirrel always moves to the opposite side. Some years ago, while quail-hunting in Clark County, Ohio, I came suddenly on one of this species which ran up a small isolated oak tree. It always kept the opposite side of the limb from the spot on which I stood. I began shooting at it, but failed to dislodge it. After shooting away two pounds of No. 8 shot, all I had, I returned to the house for more, but on my return to the tree the squirrel was gone. If two hunters are together, and go to opposite sides of the tree, the Fox Squirrel is an easy animal to shoot. In early times the Gray Squirrel was migratory in this vicinity, and at intervals passed through in prodigious numbers, swimming large bodies of water and not stopping at any obstacle in their way. I have seen several migrations, which always took place in the fall, along the Great Miami. Woods that held but few squirrels, would suddenly be alive with them; have seen dozens running along rail fences single file. The theory of the old hunters was that, when they arrived at maximum numbers in a locality, they would eat up the food and move off in search of "fresh fields and pastures new." I have heard old residents along the Great Miami speak of killing numbers of squirrels as they emerged exhausted from the river which they had swam across in their effort to go somewhere.

Our respected and venerable citizen, Jacob Hoffner, says (August 29, 1889): "I have a vivid recollection of the migration of the squirrels in vast quantities in the days of boyhood. The last one that I remember was in the autumn of 1816. They were traveling from the south to the north, and swimming the Ohio River, just below Covington, as it is now, but then a dense forest. I went to the river with other boys, armed with clubs, waded knee-deep into the water and waited the approach of the squirrels, and then with our clubs dispatched them. In that manner dozens were captured. The only reason I have for this migration, was that the crops of the forest, such as hickory and beech nuts, acorns and walnuts, etc., gave out. In the early days squirrels abounded in this country; so much so, that we boys were obliged to go to the fields a

daybreak and shout around the fields to frighten them off from destroying our corn crops." Mr. Hoffner walked from Chambersburg, Pa., arriving here on the 5th of October, 1805, and has resided here ever since. Mr. Jerry Kierstead speaks also of seeing the squirrels migrating and swimming the river, but does not remember the year. It must be some very urgent impulse that would induce a squirrel to swim a river.

Audubon, in 1819, saw a migration of squirrels (Northern Gray) swimming the Ohio a hundred miles below Cincinnati. The river was full of them, and some of them climbed on his steering oar to rest. Mr. S. F. Fletcher tells me that about fifty years ago the squirrels were very abundant in the vicinity of Richmond, Ind., and he has observed them migrating in great numbers. On his farm was a long rail fence, leading from the woods up to the cornfield. The top rails of this fence were a fávorite roadway for the squirrels, who used it in going to and from the cornfield. When he wanted a mess of squirrels he would slip quietly down, so as to get between the woods and the cornfield, and take up his station alongside of the fence, armed with a long club. Then he would shout at the top of his voice. At this the squirrels would rush for the fence and back to the woods, running the gauntlet of his club, with which he would secure his game. He says these squirrels were very fat and fine eating. The outer rows of corn would be ruined by them. The Gray Squirrel brings forth from four to six young ones at a birth, in the hole she has chosen for a nest. In this latitude they are large enough to make delicious eating about June 1st.

Dr. Langdon speaks of taking a young Gray Squirrel, only about a month old, on December 27, 1876. This would indicate a very late, or perhaps, a second brood. I do not believe the Gray Squirrel stores up nuts or other supplies for winter use, as do some of the other species. I have frequently seen them digging in the snow to hunt for a nut that was buried beneath the ground, but I think it was an accidental find. I have found quantities of nutshells in holes in their bed trees, but think they were eaten as they were carried in, one at a time. The great bushy tail of the squirrel is of great use to the animal in leaping. I once saw one in Warren County, Ohio, that had lost its tail, and in attempting to jump from one tree to another, it fell to the ground. A squirrel without its "brush" is a very clumsy, helpless sort of a creature. The Gray Squirrel (*S. Carolinensis leucotis*) occurs pure white and jet

black, though these melanistic individuals are more numerous than the white ones. I once had a black one, with large white patches on it. One in the Cuvier Club collection (No. 934) is pure snow white. It was killed from a brood of four, near Latonia, Ky. The buff colored one (No. 933) is from Auglaize County, Ohio. Our Fox Squirrel never has the white ears and nose that the Southern form does, but sometimes has the under parts jet black, as in No. 939, Cuvier Club Series. One of the Southern Fox Squirrels in same series, has the nose and ears white, with the body colored as in the Western Fox Squirrel, but the top of the head is jet black. This is No. ——, and is from Mississippi. No. 925 is one of var niger; that is, shining jet black all over, with the nose and ears white. Another one in my collection has the back gray and the entire under parts black, while one from Savannah, Ga., in the Society's collection, is gray all over, much lighter underneath. One of the "gray squirrels" (*S. leucotis*) is jet black, with the under parts yellowish brown (No. 931, Cuvier Club collection).

The nearest I ever saw the little Red Squirrel (*Sciurus hudsonias*) to Cincinnati, was in the central part of this State, where it is abundant. I have never seen the Striped and Spotted Ground Squirrel (*Spermophilus tridecimlineatus*) in Ohio, except four which I brought from North Indiana alive. These escaped and made their home in a cellar drain, but the house cat brought them in, one at a time, dead.

During the past summer I made a collection of squirrels in Colorado, from Denver to Middle Park. In the vicinity of Grand Lake the small rodents were very abundant, "Fremont's Squirrel" (*Sciurus hudsonius fremonti*) being one of the commonest. In 1857, Prof. Baird says of this squirrrel: "But two specimens, one brought in by Col. Fremont and the other by Capt. Beckwith, both from Colorado," and he says: "These two are all that have yet come to the notice of naturalists. We found them extremely abundant, and so tame that several were killed with stones. In habits they resemble the 'Chickaree' (*S. hudsonius*)." I was told that in the winter they retreat to holes, which they dig in the ground at the foot of the pine trees. They make large, bulky nests of twigs in the trees for summer beds. They are very noisy and bold, scolding and barking at an intruder, and, unlike our Gray Squirrel, if one wishes to shoot them, the more noise he makes in the woods, the better, as it excites their curiosity, and makes them show themselves.

"Say's Chipmunk" (*Tamias lateralis*) was very abundant. Several specimens were shot with their cheek pouches (which are very ample) enormously distended with grass roots, that the animal had been digging. The ranchmen told me that it was of no use to try to plant a garden, as these "chipmunks" would dig up and eat the seeds before they had a chance to sprout. The Rocky Mountain Chipmunk (*Tamias asiaticus quadrivittatus*) is also very abundant, and July 15th the young were about two-thirds grown. They are a very pretty animal. The sand-colored animals exhibited are the "Richardson's Spermophile" (*Spermophilus richardsoni*), an animal very abundant at Coulter, in Middle Park. The small gray animal flecked with white is the "Sonora Ground Squirrel" (*Spermophilus spilosoma*). I found this animal rather rare at Las Cruces, New Mexico, where it lives in burrows in the sand.

I was very anxious to secure specimens of "Abert's Squirrel" (*Sciurus aberti*), named in honor of our esteemed member, Col. Abert. I saw one at Trinidad, Colorado. It was high up on a mountain side, and it rushed rapidly away through the tops of the piñon bushes. I could not follow fast enough, as the altitude was great, and my breath gave out, and to my regret it escaped. It is the most beautiful of North American *Sciuridæ*. It has ear-tufts which are over an inch long. It is a great desideratum in most collections.

I saw thousands of "Prairie Dogs" (*Cynomys ludovicianus*) on the plains, and numbers of the "Western Prairie Dogs" (*Cynomys columbianus*) in Colorado. *Cynomys*, miscalled "dog," is a squirrel, and is nothing like a dog either in shape, color or action. Its shrill bark has nothing dog-like about it, and nothing is more inappropriate than its vernacular name of "Prairie Dog." It does not share its burrow, willingly or otherwise, with Burrowing Owls or Rattlesnakes. I have never seen *Cynomys*, *Crotalus* and *Speotyto* go into the same hole together. I think *Cynomys* does the digging, and the others appropriate the holes, either after *Cynomys* quit them, or the presence of the owls or snakes causes them to do so. This popular story of the "Prairie Dog," owls and snakes living together seems to be a myth of great antiquity.

The "Prairie Dog" sits erect on the edge of its hole, and when shot plunges into it, and quickly slips out of reach. Dr. Coues says of them: "Each tenant sits bolt upright on the mound of earth at his hole, vociferating his curiosity or displeasure, and on

our too near approach, ducking down like an automaton on springs, with a saucy "good-bye—I have business" flirt of the tail.

One of the largest of the *Sciuridæ* is the "Woodchuck" or "Ground Hog" (*Arctomys monax*), famous here about the 2d of February, on which date it is supposed to come out of its burrow for the express purpose of casting a shadow and then retiring to the depths of its subterranean den, leaving shivering mankind on the outside to wrestle with six weeks more of boreal blasts before the advent of spring. The "Ground Hog," as clumsy as it looks, can climb trees and saplings, though I think it does so but seldom. Dr. Langdon saw one climbing down out of a tree near Madisonville(3).

It was formerly abundant here, but is now seldom seen. Our "Ground Hog" is replaced in the Rocky Mountains by another larger, more yellow colored species (*Arctomys flavirenter*), that lives on the mountain side, ranging even above timber line. It lives in holes which it excavates between the rocks. It has a shrill, whistling note, that has a weird sound in these desolate places. *Arctomys* is very tenacious of life, and will fight with a dog with great fury, and will crawl into its hole after its body has been riddled with large shot. The ranchmen eat them in Colorado, first boiling them, and then baking them until they are browned. Several species of squirrels, other than those mentioned, are exhibited in this series. Messrs. Cope and Marsh have described a number of extinct *Sciuridæ* from the tertiary deposits of the West, and the bone caves of Pennsylvania and Virginia have afforded remains of others.

The following is a full list of the species and varieties of North American Squirrels, with the species added that have been published since the date of Mr. Allen's Monograph:

SCIUROPTERUS volucella Geoff.
" " volucella Allen.
" " hudsonias Gm. Allen.
SCIURUS hudsonias Pallas.
" " hudsonias Allen.
" " richardsoni Bach.
" " douglasi Gray, Allen.
" " fremonti Aud. and Bach.

(3) Ohio Geological Survey, Vol. IV., p. 125.

SCIURUS carolinensis Gm.
" " leucotis Gapper, Allen.
" " carolinensis Allen.
" " hypophæus Merriam.
" niger Linn.
" " niger Allen.
" " cinereus Linn.
" " ludovicianus Custus.
" fossor Peale.
" aberti Woodh.
TAMIAS striatus Linn.
" " lysteri (Rich.) Merr.
" asiaticus Gm.
" " borealis Allen.
" " quadrivittatus Say Allen.
" " pallidus Allen.
" " townsendi Bach.
" " dorsalis Baird.
" " harrisi (Aud. and Bach).
" " lateralis (Say).
" " macroshabdotes Merriam.
SPERMOPHILUS grammurus Say.
" " grammurus Allen.
" " beechyi Rich.
" " douglassi Rich.
" empetra (Pall).
" " empetra Allen.
" " kodiacensis Allen.
" " erythroglutæus Rich.
" richardsoni (Sab.).
" " richardsoni Cuv.
" " townsendi Bach.
" mollis Kenn.
" tereticaudus Baird.
" spilosoma Bennet.
" obsoletus Kenn.
" mexicanus (Licht).
" tridecimlineatus (Mitch.).
" " tridecimlineatus Allen.
" " pallidus Allen.

SPERMOPHILUS franklini (Sab.).
" annulatus Aud. and Bach.
" beldingi Merriam.
CYNOMYS ludovicianus (Ord.).
" columbianus (Ord.).
ARCTOMYS monax (Linn.).
" flavirenter Aud. and Bach.
" pruinosus Gm.

VARIABLE STARS.

By Wm. H. Knight.

Read before the Cincinnati Society of Natural History, July 2, 1889.

Among the stars which have received considerable attention from astronomers and physicists in recent years, none possess a deeper interest, or present more difficult problems for solution, than those technically known as variable stars.

As their name implies, they shine with fluctuating brilliancy. In some of these stars the variation of light is marked and rapid, and extends through *several* magnitudes. In other cases it is very slow and gradual, and its range may be confined to less than a *single* magnitude, so that its variable character can only be detected by a photometer, or light gauge.

Prof. S. C. Chandler, of the Harvard College Observatory, a distinguished specialist in this department of astronomy, catalogued 225 of these strange heavenly bodies in 1888, and their range and period of variation, spectra, and other peculiarities, have been the subject of careful investigation by Chandler, Sawyer, Pickering, Young, Huggins, Lockyer, and other eminent astronomers on both sides of the Atlantic.

Variable stars have been divided into many classes by different writers on that subject, but for the purposes of this paper they will be considered under three principal types:

1. Those which exhibit fluctuations of light without any indications of a regular period.

2. Those of long but not exact periods, though the terms of their maximum and minimum brightness may be approximately predicted.

3. Those of short periods, in which the minimum is of brief duration and recurs with the precision of clock-work.

Of the *first class*—those not having any recognized period—are temporary stars, and stars once bright but now dim. The most noted of the temporary stars was that known as Tycho's, which suddenly blazed out in the constellation Cassiopeia, in November, 1572. For a few days it was as bright as Venus, and could be seen

even in the daytime. It soon began to fail, but remained visible for about sixteen months, when it utterly disappeared to unaided vision. There were no telescopes in those days.

In 1604 a star shone out with great brilliancy in the constellation Ophiucus. It was called Kepler's star, and was nearly as bright as Jupiter. It continued visible with steadily waning splendor, for upward of two years, when it also disappeard.

In 1866 a small telescopic star of the ninth magnitude, in the Northern Crown, suddenly shone out with great splendor, becoming in three or four days as bright as a star of the second magnitude. Its spectrum was studied by Huggins, and exhibited the bright lines of hydrogen, "just as if," remarks Prof. Young, "it were a sun like our own, but entirely covered with outbursting prominences of incandescent hydrogen." In the short space of six weeks this star receded to its normal faintness (the ninth magnitude), and there is nothing in its present appearance to distinguish it from other stars.

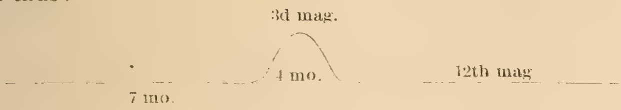
In the year 1885 a star suddenly appeared in the great nebula of Andromeda, very near the center of its nucleus. It never reached a greater brightness than the sixth magnitude, and in a few months faded entirely away so that it was not distinguishable from the remainder of the nebula.

The most conspicuous example of the *second class* of variables—those having long but irregular periods—is a star in the Whale, known as Mira, or "The Wonderful." It was first seen by Fabricius in August, 1596, as a star of the third magnitude. In October of the same year it disappeared. Seven years later, in 1603, Bayer saw a star of the fourth magnitude exactly where that of Fabricius had disappeared, but he did not note the coincidence, and *his* star faded out in a few months.

It was not till 1638, nearly forty years after its first discovery by Fabricius, that Holwarda again identified a bright star of the second magnitude as occupying the precise position of the two preceding stars, and suspected its true character as a variable. During the next two centuries it was studied by Hevelius, Herschel, Argelander and others. The telescope has enabled observers to follow it through all its gradations of brilliancy, and it now never entirely disappears from telescopic view.

Mira has a period of about eleven months. At its minimum and normal brilliancy it is of the twelfth magnitude, and remains so

for more than seven months, when it flashes up into a star of the second or third magnitude, reaching its maximum in about one month, and then more slowly fades away, dropping to its minimum in less than three months. Its ordinary light curve may be represented thus:



But this is by no means its *invariable* career. Sometimes it scarcely reaches naked eye visibility at its maximum, and its *period* is subject to strange caprices, having a variation in length of ten to twenty-five days. Even its *maximum* brightness is apparently subject to periodical changes, and its greatest brightness is believed to be at every eleventh maximum.

A large proportion of the known variable stars are of the Mira type.

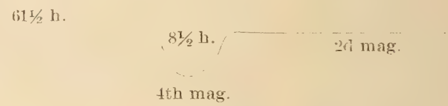
There is now a very faint star in the southern constellation Argo which has an interesting history. We can not positively assign it either to the first or to the second-class of variables, being on the border line between them. Its position is so near the South Pole that it can not be seen in this latitude. In 1677, the astronomer Halley saw it at the Island of St. Helena, as a star of the third magnitude. In 1751 Lacaille found that it had increased to the second magnitude. In 1837 its light had augmented till it fairly matched the bright star Alpha Centauri.

It then diminished slightly in brightness for four or five years, but in 1842 and 1843 it blazed up brighter than ever and nearly equaled Sirius in splendor. Then for twenty-five years it slowly and steadily diminished, and in 1867 was barely visible to the naked eye, and the year following vanished from the unassisted view. Though it has not yet begun to increase in brightness, it is suspected to be a variable of a long and irregular period.

The most striking variable in the whole heavens, and one which is at the same time a model specimen of the *third type*—those having short and exact periods—is the bright star Algol in the northern constellation Perseus. It swings from the second to the fourth magnitude and back again in a period a little less than three days. This period is as sharply defined as that of a planet in its orbit, or the rotation of a planet on its axis. It is precisely 2 days, 20 hours,

48 minutes, 55 seconds and 4·10 of a second. The precise moments of its minima have been calculated by Chandler for several years to come.

"During most of the time," says Prof. Young, "the star remains of the second magnitude. At the time of obscuration it loses about five-sixths of its light, falling to the fourth magnitude in about 4½ hours, remaining at the minimum for about twenty minutes, and then in 3½ hours recovering its original condition. During the minimum the spectrum undergoes no considerable change." Its light curve may be represented thus:



You will notice that while the light curve of Mira is upward, as if produced by a temporary outburst of hydrogen, that of Algol is *downward*, as if caused by the periodical intervention of a dark body. Are we warranted in drawing these inferences from the simple phenomena we have described?

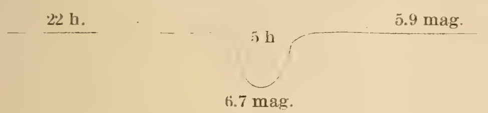
The variability of Algol was noticed as long ago as 1669 by Montanari, and its period determined in 1782 by Goodricke. Since that date some fifty astronomers have taken part in its observations and nearly 700 minima have been recorded.

But it seems highly probable the Arabian astronomers had observed these rapid variations thousands of years ago, whence their significant name, Al Gol, the demon.

Though the precise period of Algol at the present time is given to the fraction of a second, yet these long series of observations, extending over more than a century, have developed two inequalities in the Algol period. Chandler finds that the first inequality has a period of 141.3 years, with a variation of 173.3 minutes, and the second a period of 37.7 years with a variation of 18 minutes.

There are but few variable stars of the Algol type. Of these some are entirely telescopic, and others have but a slight range of brightness. For instance, a newly discovered variable in Cygnus has a maximum magnitude of 7.1 and a minimum of 7.9. Its period is 1 day, 11 hours, 56 minutes and 48 seconds. It is stationary at its maximum brilliancy for 28 hours. It then decreases 4 hours and increases 4 hours.

A new variable in Canis Major has a range only from magnitude 5.9 to 6.7. Its period is 1 day, 3 hours, 15 minutes and 55 seconds. Its light curve may be represented thus:



It will be seen that out of 27¼ hours this star has only 5 hours of partial obscuration.

How are these magnitudes determined with such precision to a decimal of one-tenth? Simply by interposing between the star and the eye a wedge of neutral tinted glass. This wedge, or light gauge, or photometer, is six inches long, and thick enough at one end to obscure the brightest stars. Its thin edge is placed at the eyehole of the telescope and then pushed along till the star under examination just disappears, when the scale on the edge is read and the star's magnitude determined.

Now in the case of Algol there are two neighboring stars just below the fourth magnitude, called respectively Gamma and Delta, the latter being the fainter. It has been found that Algol has the same brightness as Gamma 1 hour and 21 minutes before the true minimum, and 1 hour and 4 minutes after the true minimum; and that it has the same brightness as Delta 54 minutes before and 64 minutes after true minimum. We learn from this that the light diminishes more rapidly just before the minimum than it recovers after.

How shall we account for these strange fluctuations of brilliancy in those distant orbs? We must first bear in mind that each one of those tiny points of light is a great flaming sun like our own—the seat of inconceivably fierce combustion; or the nucleus of an energetic condensation of a vast mass of nebulous matter; whether gaseous or meteoric.

Are these fluctuations in brilliancy, then, due to a greater or less activity in the combustion agitating the surface of the distant sun, or are they due to an increased energy in the condensation of the nebulous mass which is forming a new sun? Or is the periodical obscuration of light observed in many stars caused by the intervention of dark bodies revolving around the distant sphere and partially eclipsing it?

These questions suggest their own answers, or rather the various theories which have been put forth to account for the phenomena observed. It is manifest that in attempting to grapple with this subject, we are questioning the very nature and constitution of those distant worlds, involving not only the mechanical structure of their systems, but the cosmical forces which brought them into being.

Prof. Newcomb, of the Washington Observatory, believes that the variability of many stars can be accounted for by supposing them to be suns like our own, and subject to similar sun-spot disturbances; only on a larger scale. It is a well-established fact that our sun has what is called a sun spot maximum, which recurs once in about eleven years, at which time its surface is often mottled with large spots.

Now, if these spots were large enough to measurably affect the sun's brilliancy, that luminary would exhibit the phenomena of a variable star to an observer in Sirius or any other sidereal orb – its period being eleven years.

Or, let us suppose our sun were to have a single spot, ten times larger than any that has ever appeared on its surface, and that spot should persistently remain for one year. Then, as the sun rotates on its axis in twenty-five days, the distant observer would see a variable star with a period of twenty-five days. But I have cited instances where the well-defined period of the variable star is but little more than one day. Now it would be a violent assumption to suppose that a great globe like our sun, much larger than the entire orbit of the moon, could rotate on its axis with that velocity—equal to about a hundred thousand miles per hour for objects on its equator.

Then again the spots on our sun do not remain permanent. They are visible but a few days, or at longest but a few weeks or months, and are constantly changing in outlines, dimensions and position. It is true that there is a certain periodicity in their abundance, and they sometimes cover the sun's surface to such an extent as to diminish the amount of light and heat given out to the surrounding planets if measured with a sensitive scientific instrument, but wholly insufficient to be noticeable at the distance of the nearest fixed star.

And it is certainly difficult to imagine a state of things where one side of the sun's surface would be glowing with present solar

energy, while the other side was wrapped in comparative gloom and darkness. We do not perceive how those antithetical conditions could be so adjusted to sharp and fixed lines of demarkation.

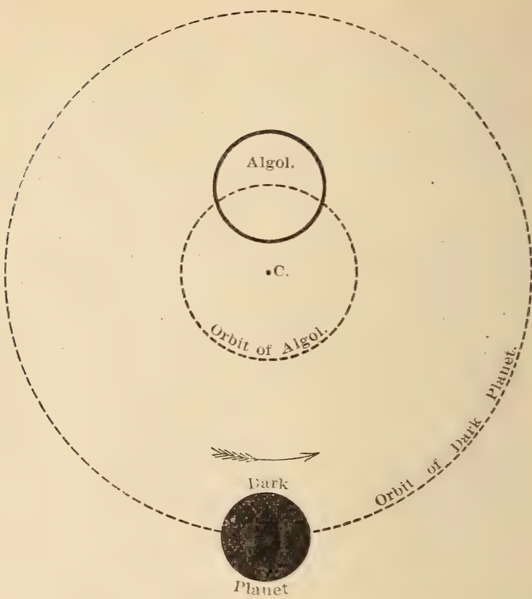
Prof. Young, of the Princeton Observatory, inclines to the opinion that variables of the Algol type—those of short and exact periods—are produced by partial eclipse, resulting from the revolution of some dark body round the luminous star and periodically shutting off a portion of its light. This theory is particularly applicable to those variables of short period where the light curve bends downward for a brief interval.

The same authority imagines that the stars of the Mira type—those of long, irregular periods—may be subject to violent outbursts of hydrogen, which, flaming up with unwonted energy for a short time, soon spends itself, and then subsides to its normal condition. This theory applies to those variables whose light curve takes a sharp bend upward and then returns to its ordinary level.

But neither of these theories is free from objections. Algol is a very large star, probably much larger than our sun. It is difficult to imagine a world large enough to cut off five-sixths of his light, revolving around him in so short a period as three days, without swaying him perceptibly from side to side. The companion of Sirius is only about one-tenth of his giant mass, and yet it produced perturbations in that great star that were noticed and measured before the telescope detected its existence.

Besides, we have seen that the light of Algol diminishes more rapidly just before the minimum than it recovers *after* the minimum. Now, if a round dark body should pass across the face of a round luminous body, the light of the latter would diminish and recover in precisely the same time.

An approximate estimate of the size of Algol, of his companion, and of the orbits in which they move, has been made by Royal Hill. He assumes that the diameters of Algol and his dark companion are respectively 6½ and 5 times greater than that of our own sun. The two great worlds, thus nearly balanced in size, revolve about a common center; the smaller at a distance of 26,000,000 miles, with a velocity of 327 miles per second, and the larger at a distance of 8,000,000 miles, with a velocity correspondingly less. The following diagram will represent their respective motions:



A later view, and one which from its boldness and originality has attracted much attention, has been promulgated by the English astronomer, Norman Lockyer. His theory refers us back to the origin of worlds and deals in a new way with the nebular hypothesis. The nebulous material was supposed by La Place to consist of highly attenuated incandescent gas. Lockyer substitutes for this gas an infinite number of small meteorites.

These meteorites are supposed to have been at one time sparsely spread out into vast nebulous, and perhaps invisible clouds, slowly drifting through space.

These clouds are in some cases immense celestial fields, much larger than the entire space occupied by our solar system.

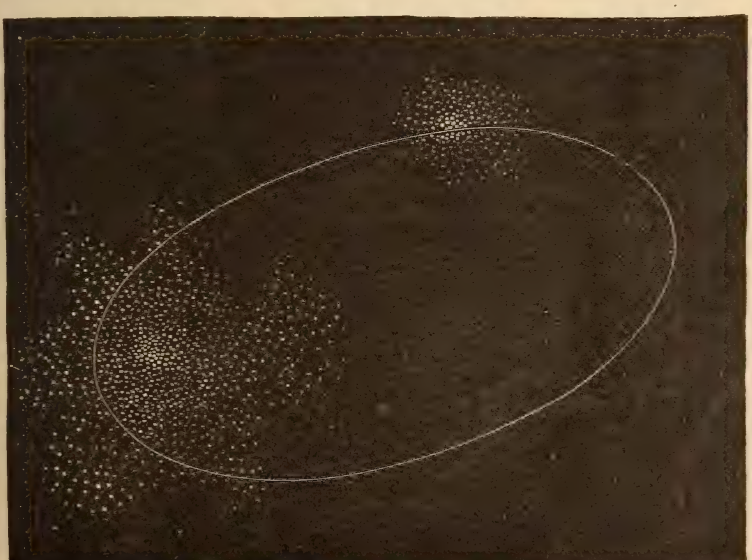
Gradually their mutual attraction causes the meteorites to approach each other and form centers or nuclei of condensation, and frequent collisions of the meteoric particles begin to take place. As the process of condensation proceeds with increasing vigor, so the velocities of the meteorites increase in a corresponding ratio, and the collisions become more frequent and more violent. These collisions produce heat not only, but actually fuse and render incandescent the substances of which the meteorites are composed.

Now imagine that such a center, in which condensation of

meteoric matter was vigorously proceeding—say an undeveloped sun—were to produce enough light by these innumerable and incessant collisions to become visible to us as an embryo star; then suppose a meteor swarm of large proportions, not yet condensed into a visible planet, were revolving about the meteoric star in a long elliptical orbit like a comet, and that at its perihelion passage of the nebulous star, it should approach so close as to pass through a portion of the outlying, sparsely diffused, uncondensed nebula; the result would be a great temporary increase of collisions and consequently of light, given forth by the incipient sun. After the perihelion passage of the uncondensed planet, the light would recede, of course, to its former intensity.

For it should be observed that not only do *stars* exhibit marked changes in brilliancy. but many instances are recorded where those intangible objects known as true nebulæ have mysteriously appeared, shone forth with steady unmistakable lustre for a time, and then have dwindled away or utterly vanished from the ken of the most powerful telescopes.

But though *some* nebulæ have newly dawned upon the vision, and *others* have entirely faded from view, and still others are undergoing perceptible changes of form and of brightness, there is no recorded instance of a nebula exhibiting any *periodical* changes in light. Variable *stars* are numerous, but variable *nebulæ* with *periodic* fluctuations of light are as yet unknown.



Is this ingenious meteoric theory supported by scientific evidence? In a series of elaborate articles published in *Nature*, which are well epitomized in a recent number of *Harper's Magazine*, Lockyer calls to his aid the spectroscope—that marvelous instrument which not only unlocks the hidden secrets of the chemical substances within our reach, but reveals the physical constitution and the very temperature of worlds wheeling in distant space. By means of this infallible agent he shows that meteorites under the blowpipe and in the electric arc present certain phenomena corresponding exactly to those observed in certain fixed stars and in many of the unresolved nebulæ.

The inference, then, seems fair that many variable stars of the first class (non-periodical) and of the second class (those having long but inexact periods) may have their rational explanation in Lockyer's theory of the collisions of meteoric nebulous matter. But for variables of the third class or Algol type (those having short, sharply defined periods with brief obscuration) a different cause must be assigned; and though not entirely free from objections, the most plausible explanation of all the phenomena observed is that which supposes the intervention of a dark revolving body.

This, of course, presumes the rather remarkable coincidence that there are several pairs of stars—one luminous and the other dark—revolving about each other in a plane identical with the terrestrial observer. But the coincidence does not seem so strange when we consider that these few cases are the only ones, so far as we know, among the sixty millions of telescopic worlds whose light converges to us from the celestial sphere.

FORT ANCIENT

By Warren K. Moorehead.

(Read September 3, 1889.)

On one of the highest plateaus in central Warren County, Ohio, overlooking the beautiful valley of the Little Miami River, is situated the greatest pre-historic earthwork in this country. This earthwork is divided by two deep ravines into two parts, which are known as the Old and New Forts. The ravines which separate the fortification into two portions extend parallel north and south for about a quarter of a mile. At one part of the fortification they come within fifty feet of each other. It is at this point that the embankments are made large and strong, and rounded somewhat after the shape of a mound. This mound-shaped extension is known as the Great Gateway. About three hundred feet north from this Great Gateway, there runs out from the embankment on each side, a crescent-shaped wall, which, in the absence of a better term, has been named the Crescent Gateway. The ends of the crescent walls come within twelve feet of each other, and the road along the top of the ridge runs between the Crescent Gateway and on through the Great Gateway. It is hardly necessary for me to say that this long narrow ridge, thus cut up by ravines, is called the Isthmus. The portion which lies north of the Crescent Gate way is named New Fort, for the reason that it has the appearance of being more recent than the rest of the fortification. That part of the fortification lying between this Crescent Gateway and the Great Gateway is designated as the Middle Fort; and that portion of the structure lying south of the Great Gateway is known as the Old Fort.

The walls of Fort Ancient have an average height of about ten feet on the inside, while their height on the outside of the extension next to the ravine reaches an average of thirty feet in altitude. The wall is very massive at the base, being about forty-five to forty-six feet in average diameter. In many places there is a layer of large flat limestones on the bottom of the wall, and lying on the original surface of the plateau. These were evidently designed to

prevent the slipping of the embankment down the hill. The hill upon which Fort Ancient is located is partly of glacial formation and partly limestone. Soil of this nature, when very wet, is apt to form land-slides; hence, the precaution taken by the builders of the earthwork.

The total distance round the fort wall, as obtained by very careful survey, is 18,712 feet; the shortest distance in a straight line from the extremity of the Old to that of the New Fort, is 4,992 feet. The area enclosed within the fortification is about one hundred and twenty-one acres. Thus it will be seen that while the embankment does not cover a great space or inclose a great area, it is so tortuous in extent as to measure nearly three and two-third miles.

Surrounding the fortification on all sides are artificial terraces, which have been, at a great expense of labor, cut into the sides of the ravine. These are one hundred and thirty-two feet above low water mark of the Little Miami River, and are about twenty feet in width. These terraces extend, in some places, for fully half a mile, and the regularity that they display is certainly remarkable, and it is not possible that they could have been formed by natural causes. It may be of interest to the geological readers of this report to here give my reasons for supposing that these terraces are undoubtedly artificial. The plateau on which Fort Ancient is situated is part of glacial formation and part limestone. Opposite the fort the valley of the Miami is very broad, but above and below it narrows. Just below the fort, the hills on each side come within two hundred yards of each other, thus almost shutting in the valley above. In glacial times the hill extended clear across the valley and made a large and deep lake. It is said by those who are considered authority on glaciology that there were many icebergs and cakes of ice floating about in this lake carrying much gravel and masses of rock. These bergs, driven by winds and directed by currents, drifted to the western side of the hill and there stranded, and remained until they melted, and thus deposited the masses of stone and gravel which they carried. So the hill, from about two-thirds of the way up, down to the bottom, is nearly all gravel. Since it was deposited, ravines have cut their way through this gravel and the water has washed much of it out into the river below, and the hill presents an irregular appearance, there being nicely rounded knolls of gravel here and there, but no regular layers can be traced

for a long distance. These terraces are above the gravel deposit, and are cut into the limestone, and in some cases nearly down to the bed-rock. Now, if they were formed by water, as some think, they would not be up one hundred and thirty-two to one hundred and thirty-five feet above the river, but would be from eighty-five to one hundred feet up, and would be entirely composed of gravel. They could not have been formed by land-slides, because they present too regular an appearance.

If a level be taken at the end of one and then at a distance of half a mile at the other extremity, we find that one end will not average one foot above the other. Then, for the most conclusive proof. We find at the depth of two feet, pottery, charcoal and a few chips of flint. This proves beyond question their artificial origin. Objects of aboriginal manufacture could not be deposited here by glaciers, as man was not here in the glacial period, but man followed; the terraces, thus, are not of glacial origin. The highest point of the plateau above low water mark is 269 feet. Adding to this the height of the embankment in the highest place, we have 291 feet above low water level.

There have been thousands of Indians buried in past ages in and about this structure. We see the places where they were interred on every prominent point, on every terrace and on every little knoll throughout the entire fortification. There is a large cemetery in the Old Fort, and the graves are very numerous in the Middle Fort, and there are evidences of burial also in the New Fort. These stone graves are divided into two classes: the stone graves proper, and the stone heaps. The stone graves are from two to three feet below the surface of the ground, and contain skeletons extended, having large flat stones on each side of them, at the head and feet, and as a covering. The stone heaps are mounds of lime and sandstone, covering a number of bodies. These bodies are rarely more than ten or fifteen inches below the surface of the ground, and much broken on account of the weight of the rock above, and much decayed because of the absorption of water from the surface. In that portion of the inclosure known as the New Fort, are four small mounds which form a rude square, being nearly equally distant from each other. An examination of these mounds yielded nothing of interest.

In the Old Fort, near the center of the fortification, is a large cemetery; this is covered by a great deal of broken pottery, bones

and flint chips, which result from an Indian village once having occupied this spot. There have been many skeletons found in this cemetery by our party as well as by other explorers. The skeletons found are enclosed in rude stone coffins of limestone, and have usually nothing whatever placed with them. The bones are in a very poor state of preservation, and very few of the skulls can be taken out entire. One or two of the individuals found had some yellow flint implements, pottery fragments and stone celts buried with them. These are shown in photographs and drawings made on the spot, and which will be used in a published account of the work. The heads that were sufficiently entire to be preserved show a considerable facial angle, and from outward appearances indicate a race of people of some intelligence. The length of the bodies found is but little below the average man of to-day. The skeletons under the stone heaps have evidently been placed there in great haste, as there was no time to erect over them a large mound, or bury them in deep graves, as were these others. We find the bones of these latter individuals in fragments from four to five inches in length, and in no case has the writer been able to take out any bones save those of the hands and feet in an entire condition. Small beads, arrow and spear heads are frequently found in these stone heaps, as if the objects had been hastily thrown in when the body was buried.

A description of this renowned place would not be complete without a brief mention of the parallel walls. These parallel walls, when measured by Messrs. Squire and Davis in 1847, were nearly obliterated. In 1809, when they were first noticed by that pioneer of American archæology, Caleb Atwater, they were very distinct, and were described by Atwater as being three and one-half feet in height, one hundred and thirty feet distant from each other, and very symmetrical in their construction. They have been cultivated over by the farmers who have occupied that region until a very slight trace of them remains, and had not our survey been well trained in tracing almost obliterated monuments, we would have been unable to follow them to their termination. The two walls start at two large mounds, just east of the fortification, and they extend in a northeasterly direction for two thousand seven hundred and sixty feet, where they terminate by inclosing a small earthen mound. They have been in all previous reports except that of Mr. Atwater given as being one thousand three hundred feet in length.

In scientific publications, such as these books that I refer to purport to be, this error of one thousand four hundred feet is unpardonable. The actual measurement with a surveying chain, as made by our party, is that given above, and is absolutely accurate.

The two mounds at the commencement of these parallel walls have been the subject of much comment by travelers on the road which passes them, and many have, in their published accounts, said that the opening of these mounds would yield wonderful results to the antiquarian. Caleb Atwater, in 1809, said that these mounds would be found to contain nothing, and Atwater was right.

The two mounds at the beginning of these walls were carefully opened from the south, and dug entirely out and afterward restored, but there was nothing whatever in them except a few pottery fragments and decayed animal bones. Between the two parallel walls (which are one hundred and thirty feet apart) is the stone pavement. The existence of this pavement has been doubted, and no one seems to have seen it or figured it. Our party opened it in several places, and found it composed of river limestone, lying on a hard bed of clay about twenty inches below the original surface of the ground. There has been considerable gravel heaped on the pavement in order to fill up the crevices between the stones and make it level. This pavement was doubtless used as a place for tribal meetings or assembly floor. This is very plausible when we consider that when the fort was built, the earth was taken from the surface of the ground, leaving a clay soil exposed, which when wet with descending rains, would be so extremely muddy as to hinder the inhabitants from holding any of their councils or ceremonial dances. This pavement would not be affected by rains, and would be a capital place for such proceedings to take place. The length of the pavement is about five hundred feet, and it extends between the parallel walls on each side. We are not aware that it is found anywhere else throughout the fortification, and are positive that a pavement of stone exists nowhere else among the ancient structures of the Mississippi Valley.

Fort Ancient was undoubtedly built for defense. Its position on this high hill, following the course of crooked ravines, placed upon points where it would be almost inaccessible, and its very construction indicate that no other purpose of erection can be assigned it. The number of skeletons found hastily buried

beneath the stone heaps, and the finding of human bones with arrow-heads embedded in them, strengthen my belief in the purpose of the structure.

It is not possible in a short sketch to go into the details concerning this structure, so my conclusions must be drawn briefly. Of all the scientific men who have visited this work, very few have assigned it any other purpose than that of defense. Military men, army engineers, and in fact every one versed in the art of war, have come to this conclusion. It is not constructed like any of the ceremonial structures. It has nothing of the serpent effigy about it. Mr. Peet, of the *American Antiquarian*, claims that it represents two massive serpents coiling about each other and engaged in a most terrific conflict. If this be true, why was not the fortification built on a plain where the curves could be made more symmetrical? Why was the wall at the base placed upon large flat limestones to prevent it from slipping and sliding? Why were not all these skeletons buried in a regular manner? Why was it not put where there were no ravines to cut it up, as were the serpent mounds and the animal effigies in Wisconsin?

The weak points, the gateways, are protected by platform mounds thrown up. There are bastions of earthwork in many places running out into the ravines, so as to afford lookout stations. Some of these, of course, are natural, but many of them have been artificially rounded and made more symmetrical. There are pits that have been six feet deeper than they now are, on the interior and exterior of this work in many places. There are found in the bottom of these ditches pottery, bones, burned stones, etc.

We have evidence of an immense population in the river valley, both above and below Fort Ancient, which could have fled to this place in case of an attack, and it is not at all unlikely that a portion of the tribe that erected the fort lived within its walls constantly. We find traces of large lodge or wigwam circles in the New Fort at this day. They are forty feet in diameter, and similar to those found on the last Mandan village site on the Upper Missouri River. No cautious man, and no one who believes what he sees, can come to Fort Ancient and work there all summer, thoroughly explore and survey, and come to any other conclusion that that this great fortification was a fortified village, and used by a large tribe as a place of refuge in case of an attack by enemies.

Some may say that a simple bank of earth would afford little or

no protection. So it would, if only placed on the plain, but the bank here is placed above ravines which have a slope in places of thirty-five to forty-five degrees, and which are one hundred to one hundred and fifty feet deep. We tried the experiment of charging up out of these ravines to the fort walls above, and in places it was so steep that we were unable to ascend except on all-fours; and when those who made the charge reached the top, they were so utterly exhausted that a slight push was sufficient to send them rolling down the steep declivity.

In the broad fertile bottom below Fort Ancient, there was once a large camp of aborigines, nearly a mile in extent, and that for so long ago that five feet of rich level soil has accumulated over the spot. By digging in many places in the bottom near the river bank, we find at the depth mentioned, ashes, charcoal, burned animal bones and pottery fragments, such as would result from long continued cooking and living in one place. Another deposit of this nature is found at a depth of two feet, which shows us that the bottom was occupied at two different periods. On the surface of the ground there have been found a number of bones, pottery fragments, etc., showing that since the Indians left the region there has but little soil accumulated, and that perhaps several hundred years elapsed between the date of the first and second villages.

The river frequently overflows this bottom, and sometimes deposits earth and frequently washes it away, so that it is impossible for us to say with certainty how old these village sites are. As there is nothing much on the surface, I come to the conclusion that the bones found there are just those which the plow has disturbed, and belong to the village at the foot of the level. In olden times the river would not overflow its banks as it does now; at least, not so extensively. Then the timber was not cut off the land, and in case of a heavy rain the water would not rapidly run down the little creeks and rivulets into the river as it does now. It would be obstructed in its passage by fallen trees and logs, and the many swamps that then existed all over our river bottoms would retain much of the water. The timber was much more heavy on the river banks then than now, and the roots running down would check and hold much of the drift, thus forming dams. Old settlers have told me that the Miami tributaries passed off a much more even stage of water when the country was first opened than now. The water is now high in the spring and low in the summer; some

times the river bed is almost dry, again it is a raging torrent. The two feet of earth above the second village site, I think, has accumulated in the last one hundred and fifty years, but the three feet between the layer lowest down and the second one accumulated when the country was heavily wooded, and therefore was much longer in forming. How long, I will not say, but it might have been two hundred years.

As to the age of Fort Ancient, it is, of course, impossible to set any certain date for its erection. The only evidence that we have we must draw from the timber which grows upon it and from the kind of soil of which it is composed, and consider about how rapidly that soil erodes.

First. Determining the age of the timber is very unsatisfactory; there is very little timber that can be classed as over three hundred years old, and none that is over three hundred and fifty. The present trees growing upon the bank are principally beech, poplar and oak. The beech and oak are the oldest; the poplar, except in the case of a few trees six feet in diameter, being rather young. We do not know how many trees flourished, decayed and fell before the present generation began its growth. So we can claim only three hundred and fifty years as the basis.

The fortification is composed entirely of tough glacial and limestone clay, which does not erode easily. Of course, it stood a number of years before the timber began to grow, and the wash was more pronounced those first years than during the entire centuries that have elapsed since. When the trees started and the grass commenced to grow, the roots of the vegetation would form a covering and a protection which the rainfall would not affect.

We do not draw conclusions, however, from this. The estimates are deduced from the following: When the fort was built there were nearly all the ravines that there are now, but some ravines have formed since. For instance, in places where there was a level when the fort was built, there has since formed a ravine or gully; this has carried out the entire wall, and has washed to the depth of thirty or forty feet in three cases that I have in mind at the present writing. Now, these gullies look just as old, and are washed clear down to the Cincinnati limestone, as do those that were in existence when the fort was completed. It must have taken centuries for this tough soil to wash out, and several geologists who have carefully examined the structure, and who have

paid considerable attention to the wearing of earth, say it could not have happened in less than one thousand years. The only estimate that seems to me to be accurate is that of about nine hundred years for the age of the structure.

The estimates given by others of from two to three thousand years, it seems to me are entirely out of proportion. I wish it understood by the reader, that this estimate as to the age, although made very carefully, is purely conjectural, and I may be as badly mistaken in giving this as any of my fellow scientists. There is one date as to the finding of a skeleton that can be placed with considerable certainty. In the center of the Old Fort there is an enormous stump six feet five inches in diameter. This is the stump of a walnut tree which was cut just twenty years ago. I found the man who cut the tree down, and held an interview with him. He was old Mr. Hughes, a farmer who had lived in the neighborhood of Fort Ancient since he was twenty years old, and he is now eighty-seven. He says that in 1820, when he first saw that tree, it was as large, as he remembered it, as it was the day it was cut down. That it was the most beautiful tree in the entire fortification. The rings on the stump, as counted by himself, indicated an age of from three hundred and forty-five to three hundred and fifty years. Adding to this the twenty years since it was cut gives us three hundred and seventy years. Several competent botanists examined this stump, and said that while the tree might not be three hundred and seventy years old, it could not be less than three hundred and twenty, so that I have given three hundred years in order to be perfectly safe as an estimate of the age of this tree. Underneath the roots of this tree there was a stone grave in which there was a decomposed skeleton. The roots of the tree grew over the stones, not under them, showing that the grave was placed there long before the tree grew.

This gives us a clew to the age of the grave—that it was three hundred years old anyway, and perhaps older. This would prove that the grave could not be that of a simple Indian, as the Shawnees did not come into the Ohio Valley until the year 1690. The reason I give this illustration, is because a great many have claimed that these stone graves are Shawnee, and are not ancient.

In conclusion, let me make a plea for the preservation of this great structure. The Serpent Mound in Adams County was bought and preserved by Harvard College. Fort Ancient is surely as interest-

ing as the Serpent Mound, and, archæologically considered, is surely more valuable. The embankments are slowly and surely melting down. The rains and the farmer's plow, the herds of cattle now kept within the inclosure, and the careless tourist, all assist in the work of demolition. He who has money must be up and doing, or this structure, like nearly all of those of prehistoric workmanship, shall soon have been known only in the past.

FORESTRY.

By Dr. N. E. Jones.

(Read October 1, 1889.)

It has been truthfully stated—it has for thousands of years undergone practical demonstration, that forests determine the climatic conditions of any given country. And for this reason forests form an indispensable basis for agriculture, manufacture and commercial industry. They also bear a near relation to the health, wealth and prosperity of a nation.

These facts being so universally admitted, it may seem strange that a government which has from its inception been so interested in the welfare of its subjects, and which has assisted and encouraged in various ways so many sources of wealth and industry, should have overlooked the forests from which the nation is drawing larger amounts of wealth than from all other natural sources combined.

The Government has ever been devoted to the interests of agriculture and manufacturing; and by premiums, by exemptions, by protections, by model farms, by grants, by bounties, by patent-rights, by technical schools, and by the introduction of superior animals and improved machinery, has fostered well these industries. The Government has not been at fault either, in donating large sums in the construction of canals and railroads, and for the improvement of rivers and harbors. It has even taken an interest in the clam and oyster, and stocked the rivers and lakes with young fish, that the devastation of these natural sources of wealth may be compensated thereby and perpetuated as a national trust; while the springs and brooks and streams—the climatic causes of disease—the necessary conditions for national wealth and national health—in a word, the importance of forests for the *Nation*, for the land, for agriculture, for the perpetuation of rivers, has received no official recognition.

But for all this, the subject is of national interest, and calls for its share of official attention. Few are so blind that they can not see, that the fires and thieves, and increasing consumption, if con-

tinued as now, can not fail to make this a treeless waste, a desolate and uninhabitable country.

Procrastination is the thief of time. The General Government should no longer postpone a definition of its policy regarding *forests*, *rivers* and its *millions of acres* of arid lands. The American people have been slow to realize the drifting of this country toward a forest famine and its destructive results It may be said, "In a republican government it is not good policy for legislation to go far in advance of public sentiment." And on the subject of forestry the people have been politically dumb; and no doubt would have remained so a much longer period, had it not been for the inspiration of Governor Morton. One cold day in January, 1872, he presented a resolution before the Agricultural Society of Nebraska, to set apart one day in each year and consecrate it to planting trees. This day was christened "Arbor Day," and is now observed by law and proclamation in thirty-one States, has entered our schools and colleges, and forestry forms part of the curriculum.

Wherever Arbor Day has been observed, it has awakened a sense of inquiry—has taught the children the names, nature and usefulness of trees, with a lasting admiration and love for them. The older people have also received an important lesson, how to use, and yet preserve their forests.

True, Arbor Day has done but little to compensate for the ten million acres of natural forests that are destroyed each year. But was it John Brown's pikes, at Harper's Ferry, that caused a bloodless emancipation? The solution of every great problem has its beginnings in peripheral strokes. The first demonstrations may appear child-like or impracticable. Still, if not the steps of logic, they are no less those of inspiration, which has, and must govern the world.

And now Nebraska, with her million acres of planted forests, has made each tree a living oracle of the gods; and Minnesota, Kansas, Iowa, Wisconsin, and other Western States, are close upon her in the right road. With laws and plantings and premiums; with schools and colleges; with the hearts of workers in it; forestry has built up a healthy public sentiment that must be felt. The Eastern States are also glistening with law officers to protect their woods from fires and thieves; and by large premiums and exemptions from taxation, have greatly promoted the interest of forestry in their respective States.

Even the State that sold her birthright—one hundred and fifty billion feet of forest for nine hundred million dollars, is not without influence for good. But what shall we say more? Others, with these, have obtained a good report, and through the schooling of "Arbor Days," have awakened a public sentiment that is marching rapidly toward the throne, and the greatest nation will speak; when that voice reaches the General Government it will be magnified in tones of thunder, for the people are waiting at the foot of the mountain for their Moses to come down.

All these little acts of the States and of the people are of much more importance than they seem. They are still small voices that can be heard afar, for the Government of the nation is not deaf to the will of the people, and is by this will ready to take the front in every good work, and in everything profitable. And in this direction it certainly would be an enterprising and profitable act on the part of the General Government to withdraw from sale or entry for one hundred years, if not perpetually, all remaining forests and all arid lands, or where the annual rainfall is below twenty inches; and place the same under the management of the Secretary of Agriculture, with ample powers and appropriations to build up a grand system of forestry, surpassing in extent and wealth combined, all those of the kings, emperors and lords of Europe. For timber-wood has something attractive besides the climatic influences it yields. It is *wealth* that becomes a never-failing source of revenue. It certainly would be sound policy for the Government to make liberal appropriations as investments, for the benefits that may be received in future forest returns.

No one can deny that something must be done; for the destruction of timber will go on increasing with the lapse of years, until the whole country is depleted of its woodlands and rendered hopelessly barren and sterile. The interest to the nation is too important to permit the Government any longer to pass by on either side in silence.

Statistics show that the annual forest crop of the United States exceeds seven hundred million dollars in value; which is more than the yield of all the gold mines and silver mines, coal, iron, copper, lead and zinc combined, and if we add to these the value of all the steamboats, sailing vessels, canal boats, flatboats and barges in American waters, the sum would be still less than the value of the forest crop by an amount sufficient to purchase at cost

of construction, all the canals, all the telegraph and telephone lines in the United States. This sum of seven hundred million dollars exceeds the gross income of all the railroads and transportation companies in the United States. It is an interest ranking first in importance, even in dollars and cents; and certainly, if for no other reason than the wealth there is in it, the subject demands the attention of the Government sufficient to enforce protection, preservation and perpetuation.

At the present time little or nothing is being done to protect and preserve the remaining forests of the public domain. All existing laws are but mockeries to the frauds, thefts and fires that are annually destroying more than one hundred million dollars' worth of this national wealth. The loss by fire alone in 1880 amounted to over twenty-five million dollars. The amount stolen annually in California, Oregon, Nevada and Washington Territory can not be estimated. A fraction of the twenty-five agents the Government has attempted to spread over four million square miles to catch the thieves, put out the fires and act as Government witnesses—a few of these faithful agents followed some of the organized bandits, and counted stumps until the value of the lumber taken amounted to *thirty-six* million dollars; and which represented perhaps only a small part of the total amount stolen by these and other gangs during the period named.

Thus, with an appropriation for protection and other purposes of seventy-five thousand dollars, and limited amount of agents, the Government has been sleeping quietly, while fraud, robbery and fire have been sweeping down the national wealth before the very eyes of the feeble and inefficient authorities. The recent fire in Montana is reported having consumed an area of timber of one hundred square miles, worth millions of dollars. And from the Cincinnati *Enquirer*, as late as last Saturday, September 28, 1889, we clipped the following: "Once more the forests of the far West are fiercely aflame. The annual loss from these conflagrations is too vast for figures to represent. It is a loss not in money only, but it ruins whole sections of country beyond the power of generations to repair. And yet there is no visible remedy."

"And yet," says that influential and progressive paper, "*there is no visible remedy.*" There is a visible remedy. Let the *people* demand it now.

It may seem expensive to maintain an army of officers and

employes to protect and perpetuate the forests of the public domain. But this great army would not be idlers. And notwithstanding it would require large appropriations, it would repay the outlay many thousand times in national wealth and national health. Nothing short of an organized department of forestry can protect and perpetuate this source of national wealth. The appropriation for this department in France is five million dollars, and is returned with good interest. Austria, not larger in extent of territory than the States of Illinois and Iowa combined, maintains thirty-two thousand forestry officers, and receives a large net income from this source. And reports show that Germany has an annual income of fifty-seven million dollars from her area of thirty-three million acres of timber. And it is estimated that no more is harvested each year than is compensated by growth and reoccupation of wasted ground.

For forest preservation does not mean that trees shall not be cut down; but that they shall be used, while all the conditions for their reproduction are steadily maintained from year to year. Consequently forest preservation means protecting, and using if necessary, an amount equal to the production by growth. This requires planting, and tree-planting and forestry mean labor in this country as it does in Europe. The United States without Alaska is, I believe, nineteen times larger in area than Germany. Therefore to be proportionately equal with this foreign power, we should have under control of the Government an area of seven hundred million acres, as a reservation for timber to supply the public necessities of the near future.

According to geological and geographical surveys, we have six hundred and forty million acres of arid treeless lands, incapable of successful cultivation without irrigation (but where trees will grow, for experiments have shown that trees will grow where the rainfall is insufficient to insure crops of grain and grass). This arid tract of our public domain should at once be made a field of labor with Government pay. It should be dedicated forever to the cultivation of timber. First along the water-courses and most favorable positions, and eventually through and over the more arid wastes, until the nation is made rich in the act.

The great railroad companies, also, should not delay in setting apart at least one million acres of their lands for "*God's first temples.*"

And here the labor question comes to the surface. For every

government that is able to sustain itself, must have something for idle hands to do. The increasing supply of labor in this country has already alarmed many thinking people—how all can find employment, which means bread. So much so, that it has been suggested that the Government construct a ship canal from the Atlantic to the Mississippi River, as a mere safety valve—to do it for the labor or bread that would be in it. But here is something better—a *necessity.* A necessity that can relieve the groaning treasury of its remaining surplus, and give employment to a vastly greater number of persons. For the labors of forestry are as immense as they are indispensable; and can end only with the end of the race. A forest of six hundred million acres, thoroughly organized and officered under the Secretary of Agriculture, would sink the post-office department and its patronage into insignificance, and would be the brightest star in the political solar system to those who are applicants for place. But this is not all—it would reclaim the arid lands, make others more fertile, the climate more healthy, the rainfall more regular and abundant; and in due time would become the incalculable wealth of the nation.

The immensity of the consumption of forest supplies can not be measured accurately; but we can form some idea of its vastness when it is known that the one hundred and eighty-seven thousand miles of railroads and one hundred and thirty-seven thousand miles of telegraph lines in this country consume each year the annual growth of a forest equal to one hundred and fifty million acres.

Nothing short of a large area of well-managed forest will prove adequate to future demands. The Government of the United States has the nucleus in her natural forests for this undertaking now; has the land for more now; has the money now. And capable men to do the work will not be found wanting.

In 1855, J. J. Stevens, Governor of Washington Territory, in his final report of surveys for a railroad across the Rocky Mountains, called the attention of the Government to the arid lands west of the Missouri River, between parallels 40 and 49 north latitude. He compared it in extent, climate, rainfall and other features to the Steppes, which occupies about one-fifth of the Russian Empire in Europe, and quotes the "commentaries of the productive forces of Russia," to sustain his statements. And we here select from these quotations to show there has been advancement even in Russia on the question of forestry. The sentences I wish to call your attention

to are as follows: " Amongst other peculiarities of the Steppes, a very prominent and distinctive one is the absence of timber. * * * * And opinions differ greatly as to the possibility of wooding it anew." Since 1855, the Russian Government has not only settled their opinions, but has adopted a policy of reforesting this two hundred and forty thousand square miles worthy of imitation.

Let our Government do as Russia is doing, and the Steppes from the Missouri River to the Rocky Mountains will soon be reclaimed and made to "blossom as a rose." And it is cheering to know, that during the last Congress, Senator Sherman introduced a bill, entitled " A bill for the preservation of the woods and forests of the national domain, adjacent to the sources of the navigable rivers and their affluents in the United States."

This proposed bill withdraws from sale and entry all timbered lands adjacent to the navigable rivers and their affluents. It also provides for the planting of trees along the course of said rivers where the land is timberless, so that the rivers may be kept in a navigable condition by promoting a continuous supply from their sources and affluents. Also to cultivate forests on the military and Indian reservations. Stating the fact, it is "*universally known that the destruction of woods causes all countries to become arid and unprofitable deserts.*"

This authorizes a commission for the examination of forests, planting of trees, fixing boundaries to reservations, etc. The appropriation for all this named in the bill is twenty-five thousand dollars, when it should be not less than two hundred and fifty million dollars annually. Just think of it—twenty-five thousand dollars appropriated to preserve the woods and forests adjacent to the sources of the navigable rivers and their affluents, to plant trees along the course of said rivers, and to cultivate forests on the military reservations and Indian territories—twenty-five thousand dollars. Although the bill looks more like an anodyne to soothe the clamoring of politics than an honest intention to do something, it must be remembered this is the first attempt at legislation on the subject, and may terminate in a fruitful ending.

It is certainly the duty of every government to embrace the *present*, to confer benefits upon its subjects, when it can not be done in the future. This nation will need oaks and pines, hard woods and soft woods, five hundred years hence as they need them now.

But trees can not be produced at will; they require time. And, if history is worth reading, if political economy is worthy of study, if past experience is not a fraud, the Government should not delay in marking out a policy, deserving of the nation, in regard to the forest and forest supplies of the United States. It can not begin too soon to anticipate the necessities of the people and generations that are to come after.

Independent of the lumber supply, experience agrees with science, that forests should bear a certain ratio to other lands in order to make a country productive as well as *healthful.* Even if all the lands are good for agricultural purposes, it would be the greatest folly to clear off all the woodland; as such policy would not fail to result in diminished crops, impaired sanitary conditions and common ruin.

This may not be believed by some, for we are all alike disposed to take the infidelity side of questions involving Providence or nature's irrevocable laws. Even a Brooklyn divine recently made the statement, "that lands watered by the ingenuity of man are *five times* more productive than those watered by heavenly showers; and that in twenty-five years there will not be between the Atlantic and Pacific Coasts one hundred miles of land not claimed either by the plow or pick, and the great waste given up to the rattlesnake, bat and prairie dog will by *irrigation* be made to support whole nations of industrious population." While the Chief of the Geographical Survey states of the arid land in the Dakotas, Montana, Washington Territory, Oregon, Idaho, Utah, Nevada, California, New Mexico, Texas, Indian Territory, Kansas, Colorado, Wyoming and Nebraska, about one hundred million acres can be irrigated and made productive. What is to be done with the remaining five hundred and fifty million acres?

When we recount the miseries and misfortunes of the eight hundred million people that meagerly subsist on the products of irrigated, treeless lands, it is to be hoped no part of this country may ever become a Spain, a China, an India, or an Egypt.

Every State and every country should have a fair proportion of the total area in timber—it is better than to have it all clothed with flocks or covered with corn—in it is the necessity for civilization and basis for a happy and powerful people.

Our own State of Ohio, which has the finest agricultural climate in the world, will soon be obliged to do something to offset the

destruction that is still going on with her little groves. When Ohio came into the Union with forty-one thousand square miles of territory, she presented the grandest unbroken forest ever beheld on this continent. A forest interspersed with hills and valleys, springs, brooks and rivers; with a soil most inviting to the aspirations of the agriculturist. The natural conditions of things were such that the possessors of this inheritance longed for the soil, and looked upon trees with less favor than they did upon those who disputed their titles with the tomahawk. Indians could be made to move away; but the trees were all disposed to stand their ground and take the consequences. Both were considered obstructions to civilization, and both in the contest got the worst of it.

The superabundance of trees was incompatible with the interests of husbandry, and the settlers were obliged to clear the land to till the soil. Forests can flourish independent of agriculture; but agriculture can not prosper without forests. This was not so visible, however, to the early inhabitants who lived in perpetual shade. War was declared—every owner and occupant of the soil combined with his neighbors in a warfare of destruction; and millions of noble trees were killed by cutting a circle around the trunk, and then left to decay. Sections of timber served in this way were called "deadnings." These deadnings were to be seen all over the country as fast and as far as settlements were made or contemplated. And now—less than one hundred years—more than seventy-five per cent. of this great forest has disappeared, and only small clumps in agricultural sections can be found in any part of the State. The announcement that the members of the Ohio State Forestry Association found a forest at Rushville with an area of eleven hundred acres, has been received with surprise.

The older trees that occupied their places in these remaining clumps, have nearly all fallen by the hand of the axman, and the younger growths are being appropriated for various purposes greatly in advance of any possible reproduction of the remaining stock; and the time is not far distant, if things go on as they have been, when the salubrious climate, with summer showers and productive soil, will be changed to one of uncertainty. We are now on the very border of that limit; still the thousands of portable sawmills are destroying all the remaining trees that will make boards, railroad ties or building lumber. And Ohio will discover when too late, that private interest is insufficient to protect forest lands, and

the State must do something as well as the General Government.

It cost France thirty million dollars to correct the evils caused by this neglect. Laws can be made and enforced to secure enough woods or timber to maintain our present climatic influences, and thus secure to agriculture that which the present greed of the landholders is making little or no attempt to preserve.

A number of years ago, the Legislature passed a law, now in force, which lost the State many millions of growing forest trees that stood on public grounds. The act reads: "Supervisors shall cut down *all bushes* growing within any county or township highway, the same to be done within the months of July and August of each year," under severe penalties for negligence or failure to perform the act.

Thus a clean sweep was made of every tree and plant, as the word "*bushes*" was legally and correctly defined to mean places "abounding in *trees* or *shrubs*." Trees of all kinds and sizes bordering the highways met their doom under this act. And every growing scion that dared since to raise its head along the borders of Ohio roads, has met a similar fate in the months of July and August each year.

If laws can be enforced to cut down trees along the public highways, laws can be made and enforced to restore them.

There are in the State approximately seventeen thousand six hundred miles of county and township roads. A tree at the distance of thirty feet on either side of these roads, would amount to over six hundred million trees. Trees that could be owned, cultivated and protected by law, and in the aggregate would form a forest equal to one hundred and fifty thousand acres.

At the same time a legal act of this kind would maintain the lawful width of roads, and prevent encroachments by adjoining land-owners, and make all our highways and byways avenues of beauty, health and pleasure. A fraction of a mill added to the tax assessment in each county as a forestry fund, and expended in planting trees along the highways, would soon accomplish the work. This, with trees similarly arranged along all the railroads, and a law placing twelve or more around each school-house, and an act preventing the cutting of "*bushes*" or *trees* growing along canals and rivers, and an exemption from taxation of lands devoted exclusively to woods, would in the aggregate form an important factor in preserving the true ratio of timber to farming lands, the

humidity of the atmosphere, and the healthful condition of the country. This should be the duty of States, but forest supplies must come from a national source, and the American people must look to the General Government, which controls the national domain, holds the keys of the vaults of the public treasury, and is responsible for this source of national wealth. To destroy the forests of a country is to subjugate the people or nation to which they belong. And if this land of the free and the home of the brave ever becomes a Dalmatia or Istra, changed from a healthful, fruitful and salubrious climate to a sterile, sickly waste, with decayed cities and crumbling greatness, the plains and valleys populated by meager sheep and goats, and equally meager owners, history can not say the "Romans did it."

Man, beasts and birds love trees. Every nation, every country, every town, in every age, has its historic trees. They are not without influence on the destiny of individuals, societies and nations. They are objects of reverence, works of time, homes of generations, and manifest wisdom of creation.

In them is seen the perfection of a wondrous living principle. A perpetuity exceeding all other forms of life. Beginning in the morning of creation and ending only with its end;—ever growing, growing, ever converting the inorganic world into another and higher kingdom;—building—building for hundreds and thousands of years, they stand before us the unfinished monuments of time.

> "The century-living crow,
> Whose birth was in the tops, grew old and died
> Among their branches, till at last they stood,
> As now they stand, massy, and tall, and dark;
> Fit shrine for humble worshiper to hold
> Communion with his Maker."

EXPLANATION OF PLATES.

DEVONIAN PLANTS OF OHIO.

By J. S. Newberry.

PLATE IV.

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Caulopteris antiqua, Newb., ... 50

Corniferous Limestone, Sandusky, Ohio.

Half of detached, floated fragment of trunk. Natural size.

PLATE V.

Caulopteris peregrina, Newb.

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Fig. 1. Upper portion of trunk, showing leaf scars, ... 52

Fig. 2. Lower and decorticated portion of trunk, showing mass of adventitious roots. Natural size, ... 52

Corniferous Limestone, Delaware, Ohio.

PLATE VI.

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Fig. 1. SPHENOPHYLLUM VETUSTUM, Newb., ... 55

Branch with branchlets and leaves. Natural size.

Corniferous Limestone, Delaware, Ohio.

Fig. 2. LEPIDODENDRON GASPIANUM, Dawson, ... 56

Detached branch, showing leaves and leaf scars. Natural size.

Corniferous Limestone, Delaware, Ohio.

Fig. 3. DADOXYLON NEWBERRYI, Dawson, ... 53

Radial section of wood, showing portion of medullary ray with clusters of areoles.

Fig. 3a. Transverse section of portion of trunk.

Fig. 3b. Tangential section of same. All much magnified.

Huron Shale, Delaware, Ohio.

THE JOURNAL

OF THE

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PROCEEDINGS.

Business Meeting, *October* 1, 1889.

Vice-President Davis L. James in the chair.

The minutes of the July business meeting were read and approved.

The minutes of the Executive Board for July, August and September were read.

The following were nominated for active membership: A. S. Berry, Julius B. Hurtig and Rev. Mr. Estil.

Dr. N. E. Jones, of Circleville, Ohio, read a paper on "Forestry," which was discussed by Messrs. Robbins, Warder, Knight, Drs. Jones, Ellis and Langdon.

Mr. E. P. Robbins exhibited specimens of black metallic nodules, and explained the manner of their occurrence in quartz crystals.

The resignation of Miss Nettie Fillmore as Curator of Botany was read and accepted.

The donations were announced and the Society adjourned.

Donations: From E. B. Johnson, specimen of Bead-snake; Robert Clarke, chart of fossil footprints (Nevada sandstone); Mrs. Esselborn, "American Journal of Science," Vol. xl, No. 2, Vol. xli, No. 2, Vols. xlii, xliii, Nos. 1, 2.

Reception, *October* 17, 1889.

An informal reception was given at 8 P. M., to a number of members of the Ohio Archæological and Historical Society of Columbus, Ohio.

Vice-President James presided.

Addresses were made by Dr. F. W. Langdon, Mr. Graham, Dr. Chas. W. Super and Rev. Mr. Parsons.

Scientific Meeting, *November* 5, 1889.

It being the night of the State election, no quorum was present, and the meeting was adjourned by President Fisher, to November 12, 1889, at 8 P. M.

Adjourned Scientific Meeting, *November* 12, 1889.

President Fisher in the chair. There were twenty-five persons present.

The minutes of the September scientific meeting were read and approved.

The minutes of the Reception of the members of the Ohio Archæological and Historical Society on October 17, 1889, were read.

Dr. Chas. E. Caldwell read a paper entitled: "Hypnotism from a Scientific Standpoint," which was discussed by Messrs. Skinner, Harper, Drs. Norton and Keckeler.

Dr. O. D. Norton gave an account of a visit to the Natural Bridge of Virginia.

President Fisher read a paper entitled: "Differences between the Asiatic and African Elephants."

Mr. Skinner read a letter from Mr. William T. Garratt, of San Francisco, California, stating that he had shipped a large and valuable collection of specimens to the Society.

The following were nominated for active membership: H. S. Brooks, Raymond Cilley, Henry A. Gleick, J. L. Green and Dr. C. N. Cooper.

The following were elected to active membership: Julius B. Hurtig, A. S. Berry and Rev. Estil.

A vote of thanks was extended to Messrs. Erasmus Gest and Chas. H. Kilgour for their efforts in behalf of the collections donated by Mr. Wm. T. Garratt.

The valuable donations of Pacific Coast minerals and specimens of Ethnology, etc., were ordered to be placed in separate cases for exhibition and labeled "The Garratt Collection," in honor of the donor. A vote of thanks was likewise extended to Mr. Garratt for the same.

The list of donations was read and the Society adjourned.

Donations: From Davis L. James, miscellaneous pamphlets; Mrs. Esselborn, several numbers of "American Journal of Science;" Miss Florence Wells, specimen of Itacolumite; Mrs. Henshall, specimen of bird's-nest Fungus; H. A. Smith, Fungus; Dr.

O. D. Norton, photographs and rock from Natural Bridge of Virginia; Dr. R. S. Michel, two relics—one boat-stone, one ornament.

SCIENTIFIC MEETING, *December* 3, 1889.

President Fisher in the chair. There were twenty-six persons present.

The minutes of the November scientific meeting were read and approved.

Dr. Henshall read a paper entitled: "Some Observations on Ohio Fishes."

Mr. George Bullock read a paper entitled: "Photography as applied to Natural History," illustrated by lantern views.

The catalogue of the "Garratt Collection" was ordered printed in the JOURNAL.

Mr C. L. Herrick was elected Curator of Botany in place of Miss Nettie Fillmore, resigned.

The list of donations was read and the Society adjourned.

Donations: "The Garratt Collection," by Wm. T. Garratt; E. O. Hurd, mounted specimen of White Pelican.

THE GARRATT COLLECTION.*

The following valuable and very interesting specimens in Mineralogy, Botany, Zoology and Ethnology were donated by William T. Garratt, Esq., of San Francisco, California. They are properly arranged and well displayed in suitable cases under the name of "The Garratt Collection."

The specimens are particularly fine and perfect, and some of them are quite rare. They were obtained through the personal efforts of Mr. Garratt, at the solicitation of Messrs. Erasmus Gest and Chas. H. Kilgour, for the Museum of the Cincinnati Society of Natural History.

Mr. Garratt formerly lived in Cincinnati, but went to California in 1849, where he accumulated a large fortune in the manufacture of mining and agricultural machinery. He is one of the most esteemed and influential citizens of San Francisco, and through his extensive acquaintance with ship owners and officers, mining engineers, explorers and others, he has induced a number of them (whose names appear in this catalogue) to donate many valuable articles to this collection.

Mr. Garratt has signified his intention to add to the collection, from time to time, in order to make it as complete and attractive as possible.

CATALOGUE.

From Wm. T. Garratt, Esq., San Francisco.

Gold Quartz; North Star Mine, Trinity Co., Cal.

Free Gold Ore; North Star Mine, Trinity Co., Cal.

Obsidian; Lake County, Cal.

Garnet Rock; very fine; Wrangel, Alaska.

Specimens of Rocks; sea-beach, San Francisco.

Volcanic Ashes; Rancho Laguna de la Merced, Cal.

Pacific Ocean Water; sixty miles west of San Francisco.

Teredo Navalis; from the Cradle to the Grave; growth, etc.

Wharf Piles; 7 specimens, eaten by *Teredo navalis.*

Oregon Yellow Fir; 2 sections, showing the work of the *Teredo.*

*Mr. Wm. T. Garratt died at San Francisco, Cal., January 14, 1890.

New Zealand Karn Wood; destroyed in 2 years by *Teredo.*
Australian Blue Gum (*Eucalyptus Globulus*); destroyed in 3 years.
Redwood; destroyed by *Teredo* in 2 to 3 years.
Oregon Fir; driven in 1886—taken out in 1889.
Pile Coating; samples covered with petroleum sediment.
Knot; from Maple tree; curious specimen.
Abalone Shells; 2 specimens; very fine.
Siempre viva plants; and Tamarinds.
Tarantula; 1 specimen. 2 Tarantula nests.
California Silk-worms; Photograph, colored; Life history.
Terra Cotta Images; 8 specimens; showing costumes of Mexican Indians.
Terra Cotta Busts (in miniature); of 8 Presidents of Mexico.
War Clubs; 3 specimens; New Caledonia.
Canoes and Paddles; 3 specimens; Yukon River, Alaska.
Skin Canoe; with 2 figures of Fur Sealers; Kodiak, Alaska.
Sea Porcupine; (*Diodon hystrix*); one specimen; fine.

From W. R. Low, Esq.

Army Jacket; made of vegetable fibre; South Sea Islands.
Helmet; worn with army jacket; South Sea Islands.
Club; used in making cloth; South Sea Islands.
Women's Hats; worn by wives of chiefs; South Sea Islands.
Necklace; worn on ceremonial occasions; South Sea Islands.
Shirt; made of cocoanut fibre; South Sea Islands.
Woman's Dress; made of leaves; Gilbert Islands.
Native Paint Pot; Gilbert Islands.
Saw of Saw-fish; Gulf of California.
Native Hat; Caroline Islands.
Native Drum; only musical instrument of the natives; South Sea Islands.
Wooden Chest; belonged to native chief; South Sea Islands.
Woman's Dress; every-day dress; leaves; South Sea Islands.
Lauhala Leaves; used for clothing, mats, etc.; South Sea Islands.
Mat; made of Lauhala leaves; South Sea Islands.
Native Basket; made of cocoanut leaves; South Sea Islands.
Necklace and Girdles; 12 specimens; very curious; South Sea Islands.
Hair Pins; made of wood: curious; South Sea Islands.

Shell Fish-hook; 1 specimen; very fine; South Sea Islands.
Spears and Lances; several specimens; South Sea Islands.

From Leander Cox, Esq.

Adze; formerly used in making canoes; Alaska.
Vampire Bat's Wing; large specimen; Alaska.
Arrows; used by Alaska Indians; Yukon River, Alaska.
Powder Horn; made by Indians; Yukon River, Alaska.
Ivory Fish-hooks; 3 specimens; fine; Yukon River, Alaska.
Set of Chess-men; carved by natives from bone; Yukon River, Alaska.
Native Bow; 1 specimen; Yukon River, Alaska.
Native Spears; 2 specimens; Yukon River, Alaska.
Skins of Fur-Seal; 2 specimens from seal pups; Tanack, Alaska.
Native Sword; edged with shark teeth; Feejee Islands.
War Club; 2 specimens; Feejee Islands.
Boomerang; fine specimen; Australia.

From H. Tripp, Esq.

Pop-gun; made by Mexican Indian boy; Mexico.
Woods of Mexico; many fine specimens; Mexico.
Mica; taken from a deer's stomach; Sinaloa, Mexico.
Insects; 3 cases of many fine species; Mexico.
Scizzor-bird; or Patagonian pigeon; one skin.
Blue birds; 2 skins of Mexican jay-bird; Sinaloa, Mexico.
Spanish Book; "Conquest of Mexico," a Poem, 1755; very valuable.

From Capt. Gustaye Niebaum.

Head of Walrus; also, walrus bones; very fine.
Beak of Saw-fish; fine specimen.

From Charles Watts, Esq.

Gold Quartz; also Sulphurets; Brown Bear Mine, Trinity Co., Cal.

From Ch. Rechtnagel, Esq.

Gold Quartz; same, crushed; Placer Co., Cal.
Placer Gold; in vial; Newhall, Cal.

From H. Brown, Esq.

White Seal-Skin; caught by whaling bark "Reindeer;" Siberian coast.

Boar's Tusks; 4 fine specimens.

From Capt. T. P. H. Whitelaw.

Canoe, with out-riggers; very fine model; Feejee Islands.

From J. D. Sprecklés, Esq.

Mammoth Tusk; very fine specimen; Alaska.

From Adolph Thrickler, Esq.

Volcanic Lava; from volcana of Kilalauea, Sandwich Islands.
Pine Cones; 2 specimens; California.

From J. & T. Kesseler.

Onyx; from St. Lucia Mts., San Luis Obispo Co., Cal.

From California State Mining Bureau.

Minerals; a large and valuable collection; California.

SOME OBSERVATIONS ON OHIO FISHES.

By Dr. James A. Henshall.

The State of Ohio is drained by two great water systems—the St. Lawrence River and the Ohio River. A broad dividing ridge, separating the waters of the two systems, begins in Ashtabula County, in the northeast corner of the State, and running west-southwest, extends to Mercer County. Thus the lower two-thirds of the State is in the Ohio Valley, and the upper third in the basin of the Great Lakes.

The elevation of Lake Erie is 565 feet, and of the Ohio River at Cincinnati 429 feet above tide water, the river at Cincinnati thus being 136 feet below the level of Lake Erie. The great water-shed is from 1100 to 1350 feet above sea-level, and is cut through by four wide valleys, the deepest of which, however, is probably not less than 250 feet above Lake Erie. Through these valleys flow streams to the north and south. Through the most easterly one Grand River runs to Lake Erie, and the Mahoning to the Ohio River; through the next one flows Little Cuyahoga River to the north, and the Tuscarawas to the south; in the next valley are the Black and Killbuck, flowing in opposite courses; and in the most westerly one the Sandusky, Portage and Maumee flow north-east, and the Wabash to the southwest. Along the summit of the dividing ridge are also lakelets, ponds and marshes.

The forty thousand square miles of the great State of Ohio are well watered and drained by numerous streams, both large and small. Almost the entire northern boundary of the State is washed by the pure waters of Lake Erie, while the beautiful Ohio, one of the great water-ways of the world, flows along its southeastern border.

All of these waters are inhabited by fishes of high or low degree, from the monster sturgeon to the liliputian darter an inch in length—one of the smallest vertebrates known.

There are in the waters of the world nearly ten thousand described species of fishes, fully seventeen hundred of which are found in North America. Of these the fresh waters of North America furnish some six hundred species, and the waters of the State of Ohio contain at least one-fourth of this number. The fresh-water fishes

of North America are comprised in 30 families, 25 of which are represented in Ohio waters, about as many as in any inland State.

The earliest investigation or mention of the fishes of Ohio in a scientific way was by C. S. Rafinesque, a Franco German naturalist, born in Constantinople. During the years 1818 and 1819 he explored the Ohio and its tributaries from Pittsburg to the Falls of the Ohio, at Louisville, and published the results of his labors in various scientific journals of the United States and France. In 1820, while Professor of Botany and Natural History in Transylvania University, he published at Lexington, Ky., his "Ichthyologia Ohiensis, or Natural History of the Fishes inhabiting the River Ohio and its tributary streams."

In this little work of ninety pages Rafinesque describes 111 species, of which but about one-half have been since identified as valid species, as some are evidently "myths" described to him by other persons, and in many cases he has described a species under several different names, and still others are so far unidentified. Of the 55 or 60 valid species, all but three—the alligator gar, the brook trout and the saw-fish—in habit the Ohio or its tributaries within the limits of the State of Ohio.

In 1838, Dr. J. P. Kirtland, in his "Report on the Zoology of Ohio," gives a catalogue with descriptions of 72 species, and later, in 1840–46, he published in the *Boston Journal of Natural History* a series of papers on the "Fishes of Lake Erie, the Ohio River and their Tributaries," in which he gives excellent descriptions and tolerable figures of but 66 species, having omitted or suppressed a few species of his first list.

In 1876 Mr. J. H. Klippart, in the first report of the Ohio Fish Commission, describes 26 species of food fishes, compiled from the manuscript of Dr. David S. Jordan by Prof. Chas. H. Gilbert; and in 1878, in the second report of the Commission, Mr. Klippart describes 22 additional food fishes of Ohio, though several of them were included in his first list under different names. The scientific descriptions of the genera and species of this list were compiled from the manuscript of Dr. Jordan by Dr. E. Copeland.

In 1882 Dr. Jordan published a "Report on the Fishes of Ohio," in Vol. IV of the Geological Survey of Ohio. In this report Dr. Jordan gives very full descriptions of 165 species, supposed to inhabit the waters of Ohio, based on the papers of Rafinesque and Kirtland, and on his catalogues of the fishes of Indiana and other

States bordering on the Ohio River. In an emendation of this list recently sent to me by Dr. Jordan—after eliminating doubtful and extra-limital species—it is reduced to 130 species; but he named some 15 other species as likely to occur in Ohio waters.

In the spring of 1888 I began to make a catalogue of the fishes of Ohio from actual observation, and to secure a collection of the species observed for the Museum of this Society, which at that time contained but four specimens of Ohio fishes, viz.: stuffed and mounted examples of a sturgeon, a paddle-fish, a gar, and an eel. Accordingly, in April and May, Prof. C. H. Gilbert and myself explored several streams in Hamilton County, and obtained therefrom—within a radius of ten or twelve miles of Cincinnati—70 species; as many as Kirtland described from the entire State, and more valid species than Rafinesque described from the Ohio and its tributaries from Pittsburg to the Mississippi.

In July of the same year I spent two weeks at Put-in-Bay, Lake Erie, making collections; and in August, Professor Gilbert and I devoted three weeks to the exploration of the Ohio and its tributaries, between Cincinnati and Marietta. From Lake Erie and the streams of the Ohio basin, 40 additional species were added, making a total of 110 species actually observed and identified, lists of which were published in the JOURNAL of this Society for 1888–89.

During the summer and early fall just passed I made still further collections in Lake Erie, in the vicinity of Put-in-Bay, which I am now working up. I was hopeful of getting through with them in time to embody the results in this paper, but have not been able to do so, fully; I think I can safely say, however, that I have about 130 species of Ohio fishes at the present time.

It may not prove uninteresting to allude to a few facts concerning the fishes of Ohio, and more particularly to those known as food-fishes. For the sake of convenience of description I will consider them by families, and in the order of their commercial importance.

Family SALMONIDÆ. The Salmons.

THE WHITEFISH (*Coregonus clupeiformis*) comes first in this prominent family, and is far ahead of all other fresh water fishes for its exquisite delicacy and richness of flavor, and among salt water fishes is excelled by but one, the pompano, in my opinion. It is in its best condition in the fall, and though it is then a "fat" fish, it does not cloy the palate like the Atlantic salmon, mackerel and other "oily" fishes.

This fact is recorded in the writings of such early explorers as Father Marquette, Charlevoix and Sir John Richardson, who subsisted on it for months at a time without losing a relish for it. Richardson says: "It is a rich, fat fish, yet instead of producing satiety, it becomes daily more agreeable to the palate; and I know from experience that, though deprived of bread and vegetables, one may live wholly upon this fish for months, or even years, without tiring."

To a certain extent I can corroborate Richardson's statement, for I have eaten broiled whitefish at the Old Mission House at Mackinac for twenty-one meals a week, and, like Oliver Twist, asked for "more." But to realize the delicious savor and flavor of the whitefish it should be broiled when perfectly fresh, for if in poor condition, or long out of the water, it loses entirely its characteristic excellence.

Perhaps the fine flavor of the whitefish depends upon its food, which is now known to consist entirely of animalcules, or, to be more explicit, of minute and microscopic mollusks and crustaceans, the latter commonly known as water-fleas. The copepods of the class of crustaceans known as *Entomostraca* furnish the principal amount of food for the whitefish, both in its young and adult states. The whitefish is a toothless fish, but for a brief period, soon after it is hatched, it is provided with several sharp, raptatorial teeth for seizing the microscopic copepods.

Entomostraca exist in myriads in all waters, both salt and fresh. Some are so minute that several millions can be contained in a single cubic inch of space. With every glassful of lake or river water we drink, we may swallow hundreds of these animalcules, and they are quite nourishing, so far as they go. The copepods are very prolific. The progeny of a single female of one species has been calculated to reach the enormous number of over four billions in a single year!

As a commercial fish the whitefish likewise stands at the head of its class among fresh water fishes. Millions of dollars are invested in nets, boats, implements and appliances, and thousands of men are employed in the fisheries of the Great Lakes, the whitefish being the principal object of pursuit. The south shore of Lake Erie fairly bristles with the stakes of the pound-nets engaged in its capture.

Owing to wasteful and improvident fishing, the catch of white-

fish began to steadily diminish some years since, until the work of the artificial culture of the whitefish and the re-stocking of the lakes was begun some ten or twelve years ago by the U. S. Fish Commission and the Fish Commissions of the States bordering on the Great Lakes, to endeavor to restore the fisheries to their former prestige and profit. This work has been steadily carried on from year to year, and the good results from it began to be apparent three or four years ago, the catch increasing each year, until last season, according to the report of the Ohio Fish Commission, the catch of whitefish was unprecedented.

The average weight of the whitefish is two or three pounds, sometimes running up to five or six, and occasionally monsters of twenty pounds have been taken. They spawn in November, the eggs hatching the following April.

The Lake Trout (*Salvelinus namaycush*), next to the whitefish and lake herring, is the most numerous of lake food fishes, though it occurs in greater numbers in the upper lakes than in Lake Erie, where it is mostly confined to the deep waters of its eastern portion. It is considered next to the whitefish for the table, and is very voracious, living mostly on fish diet, which consists principally of the cisco, a smaller member of the salmon family. It grows to a large size, some thirty or forty pounds being its maximum weight. It spawns in October, before the whitefish, the young hatching the following February.

The Lake Herring (*Coregonus artedi*) has increased very much in numbers during the past few years, so that it is now the most numerous species taken in the pound-nets, and is considered rather a nuisance than otherwise by fishermen. They resort to the shallow portions of the lakes in great schools, and during the spawning of the whitefish they completely gorge themselves with the eggs of that species. At other times their food seems to consist of insects and crustaceans.

The lake herring is not much valued for food, though it is by no means to be despised in this particular. It has no special flavor when fresh, but if slightly salted and smoked it is delicious. Considering its character as a spawn eater, it is very unfortunate that it is increasing in such vast numbers.

It rarely grows to exceed a foot in length, or a half pound in weight. It spawns a little later than the whitefish.

The Brook-Trout (*Salvelinus fontinalis*), the loveliest fish in

fresh waters, is found in but one stream in Ohio, so far as I know—Castalia Springs Creek, a few miles south of Sandusky. In 1873–74, Mr. Hoyt, then the owner of the springs, hatched some thousands of trout eggs and deposited the fry in these waters, where they have multiplied and increased, the low temperature of the water, even in summer, rendering this stream well adapted to their welfare. The spring and stream are now owned by a wealthy angling club. The brook-trout is too well known to be particularly mentioned, but it is fast disappearing before the axe of the lumberman in the States to which it is native.

Family CENTRARCHIDÆ. The Sunfishes.

The Black Bass (*Micropterus*) is the most important member of this family. The large-mouthed black bass (*M. salmoides*) is common in Ross Lake, near Elmwood, some eight miles from this city, and not rare in the streams emptying into Lake Erie and the Ohio River. Ross Lake is fed by the Miami Canal, through which the large-mouthed bass and other lake fishes have found their way into this lake.

The small-mouthed bass (*M. dolomieu*) is abundant in Lake Erie, especially about the islands in the western part of the lake, and in all of the streams tributary to the Ohio from the Little Miami to Pittsburg; and judging from the great numbers of the young that I took in my collecting seines, and threw back to grow, this best of all game fishes will, like the poor, be with us always, if they are properly protected during their breeding season, seining prohibited, and the streams kept clear of the pernicious emanations from the various factories, oil refineries and distilleries.

It goes without saying that the black bass is my favorite game-fish. It is now *the* game-fish of our country. After an ample experience in the capture of every game-fish of American waters—from the lordly salmon of Canada to the tarpon, or "silver king" of Florida—from the striped bass of the Chesapeake to the mascalonge of the Great Lakes—I consider the black bass (as I have often said before), inch for inch, and pound for pound, the gamest fish that swims.

As a food-fish the black bass bears transportation well, and ranks next to the whitefish among fresh water fishes, and usually sells for a better price.

It spawns in the streams of Southern Ohio in May, and in the

tributaries of Lake Erie, and in the lake itself, in June and July, depending on the temperature of the water. The eggs hatch in a week or two, depending also on the temperature of the water. The parent fish carefully guards the nest, keeping away all trespassers, and continues to protect the young after they are hatched until they are able to take care of themselves. The food of the black bass consists principally of crawfish, varied with insects and minnows.

The calico-bass, or straw-bass (*Pomoxis sparoides*), and the croppie, or new-light (*Pomoxis annularis*), and the rock-bass, or red-eye (*Ambloplites rupestris*), are all well known and much esteemed. They grow to a pound or two in weight, and are excellent pan-fish. The calico-bass is common in Ross Lake, coming from Lake Erie by way of the Miami Canal, and is also abundant in all of the canal reservoirs of the State. The croppie, or new-light, I found common in the Ohio and its tributaries above New Richmond.

There is a current story that the croppie first appeared in the streams of Kentucky simultaneously with the advent of the disciples of Rev. Alexander Campbell, hence one of its vernacular names of "New-light," a name bestowed on this religious sect in common with "Campbellite," by which latter name the croppie is also sometimes known; but while this may be true of the streams of Central Kentucky, this fish was described by Rafinesque from the Falls of the Ohio in 1819.

The late Dr. Kirtland had a very high opinion of the calico-bass, or "grass-bass," as he called it. He says: "From a long and intimate acquaintance with its merits, I hesitate not to pronounce it the fish for the million. * * * As a pan-fish for the table it is surpassed by few other fresh water species." And the good Doctor was right. If the same care, enterprise and enthusiasm had been devoted to its introduction into the ponds of our State, as in the case of the worthless German carp, the farmers and people at large would have a fish fully worthy of their zeal, for both the calico-bass and the new-light are pond fishes *par excellence*.

The smaller sunfishes or "sunnies" (*Lepomis*) are also good pan-fish, and furnish fine amusement and recreation for youthful anglers.

Family PERCIDÆ. The Perches.

The yellow perch, or as it is sometimes called, ringed-perch (*Perca flavescens*), is abundant in Lake Erie and its tributaries, and

in the canal reservoirs, but it has not yet reached the Ohio River, so far as I have seen. It is a pretty fair pan-fish in some waters, but worthless in others. It is a bold "biter," and is a source of much pleasure and amusement to young anglers.

The pike-perch (*Stizostedion vitreum*), or as it is erroneously called, "salmon," or "Ohio salmon," is a very valuable game and food fish, and is one of the commonest fishes in our markets. It is supplied to some extent by our local fishermen, but the greatest number are shipped from Lake Erie. It bears transportation well, the flesh being hard, white, flaky and of a good flavor; consequently it is much esteemed during the Lenten season. It is a very desirable fish for lakes, or rivers with a good depth of water, being hardy and prolific, and is altogether one of the best percoid fishes.

I found the young very common in the Upper Ohio and other large streams, as the Muskingum and Scioto, in which streams they seemed to be increasing, no doubt owing to the planting of the species by the Ohio Fish Commission.

The beautiful little "darters" of our rapid, clear brooks belong to the perch family. They grow from an inch to several inches in length, and the many different species are wonderfully barred, and striped, and spotted with gay and brilliant colors—green, orange, blue, scarlet and yellow. Some are transparent and lie hidden in the sand; others lie under the stones and bowlders of the riffles, and dart from one rock to another—their large, broad and brilliant fins expanded—as swift and as graceful, as beautiful and as unique among fishes, as humming-birds among the feathered tribe. I have collected some twenty species of these interesting little fishes in Ohio waters. They constitute the poetry of the science of ichthyology.

Family SILURIDÆ. The Catfishes.

The different catfishes occupy an important place as cheap food fishes, one of the best being the forked-tail channel cat (*Ictalurus punctatus*) of the Ohio and its large tributaries. I found it very abundant, especially in clear streams, which it prefers to the muddy water usually frequented by others of the family. It grows usually to two or three pounds in weight, though sometimes reaching six or eight.

Some of the square-tailed cats and bull-heads (*Amieurus*) are more esteemed for food, however, than the channel cats, and sell

readily in the market to the poorer classes, especially to the negroes, though for that matter they are fit to grace the table of an epicure, if properly cooked. I saw one mud-cat weighing sixty pounds, and one of seventy-five or more, last year—though I have seen much larger ones years ago. I once saw one taken in the Ohio near Cincinnati weighing 120 pounds

Most catfish, if not all, make their nests in holes in a bank, and after the young are hatched, care for them and protect them until able to look out for themselves.

Family ACIPENSERIDÆ. The Sturgeons.

We have two sturgeons in the Ohio River, one of which (*Acipenser rubicundus*) is also common to Lake Erie, where it is known as the rock sturgeon. It grows sometimes to a length of six feet, and to nearly or quite two hundred pounds in weight, though those taken in the pound-nets average but fifty pounds. The sturgeon is used to but a very limited extent as food when fresh, but it is in considerable demand when smoked, when it is very palatable and wholesome, and a good deal of it is sold as "smoked halibut." The roe, or eggs, is made into caviare.

Another sturgeon, and one peculiar to the Ohio, is the curious shovel-nosed sturgeon, which is not used as food to any extent. It does not grow to quite so large a size as the rock sturgeon, but it has a much longer name—*Scaphirhynchus platyrhynchus*.

The sturgeons are queer fishes in every way, and not the least curious feature about them is their manner of feeding and the character of their food. This immense fish has no teeth, and its mouth is underneath, over which hang four fleshy barbels or "feelers." It feeds almost entirely on small, thin-shelled mollusks, principally gasteropods, or fresh water snails, which it finds in comparatively shallow water, by means of its feelers, or barbels.

The paddle-fish or spoon-billed cat (*Polyodon spathula*) is another very queer animal, belonging to a different family, but somewhat related to the sturgeons. Its body is like that of the catfish, being smooth and scaleless, and without the horny plates of the sturgeons. It is not unlike the sharks in some features. It snout is prolonged into a flat paddle or spatula. It has no teeth in its adult state, but has a very curious straining apparatus connected with its gills, by means of which it feeds entirely on the smallest crustaceans of the class *Entomostraca*, which you will remember are

very minute or microscopic animals, and which furnish food for the young fry of other fishes. As the paddle-fish is not used for food, and grows to a very large size (I have seen them weighing from seventy-five to one hundred pounds), it must be considered in the light of an evil and a nuisance so far as other fishes are concerned, devouring as it does enormous quantities of the food required for the young of desirable species. This fish, with the sturgeons, gar-fish and dog-fish, forms a connecting link between fossil and living fishes, and as such is very interesting to the biologist.

Family CATASTOMIDÆ. The Suckers.

It is well that the tastes of people differ so widely, for while the suckers are despised by many, they are esteemed quite highly as food fishes by others, and it is indeed surprising to see how readily the buffaloes, carp-suckers, red-horses and other coarse suckers sell in the markets—*De gustibus non est disputandum.* These fishes, with the catfishes, are among the most abundant species in the Ohio and its tributaries, as I found them everywhere in the larger streams, and their young in the smaller ones.

The suckers, like the minnows, have no teeth in the jaws or mouth, but have teeth of various sizes and shapes in the throat, called pharyngeal teeth. These teeth are usually long and sharp, but one species, which resembles the common red-horse in all its external features, can be distinguished from it only by the teeth in its throat, which are truncated, like a row of small posts. The suckers are both herbivorous and carnivorous.

Family SCIENIDÆ. The Drums.

The only fresh-water member of the drum family is the abundant species known as the "sheepshead" in Lake Erie, and as the "white-perch," grunting-perch, or gaspergou in the Ohio and its tributaries. It is found everywhere in our larger streams. It sells readily in the markets, and is a much better fish in the Ohio basin than in the lakes, which, however, is not saying much for it.

The most important teeth of the fresh-water drum are in its throat, and resemble a pavement of bowlders on a small scale, by means of which it cracks the shells of the mussels or fresh-water clams very easily; its food consists mainly of these bivalves, which it grinds up and swallows, shells and all.

Family CYPRINIDÆ. The Minnows.

To most persons all minnows are either "chubs" or "shiners," and are by many supposed to be merely the young of large species. Most of them, however, do not grow more than three inches in length, though two or three species grow to be six or eight inches long. There are at least fifteen genera and thirty species in the Ohio waters. Many of them, during the spawning season in the spring, put on very brilliant and beautiful nuptial dresses, rivaling the darters in their gay appearance.

The largest of the minnows, the real "chubs," are quite palatable when fried brown and crisp, but they are mostly used for bait by the angler, and furnish food for larger fishes.

The European minnows grow to a larger size than ours, some of them being very large fishes. The European members of the family which have been introduced into this country, the German carp and gold-fish, are now found in many of our streams, having escaped from overflowed ponds. I have seen some very large carp and gold-fish in Ross Lake, and saw two large mirror-carp at Remington that had been taken on a trot-line with helgramite (larva of *Corydalus cornuta*) bait, in the Little Miami River.

Other fishes that I found very abundant were the herring-like forms known as gizzard-shad, skip-jack and toothed-herring, which, while worthless for the table, are very valuable and important, inasmuch as they furnish food, while young, for nearly all, if not all, of our more desirable food-fishes and game-fishes. The gizzard-shad has a very thick, muscular stomach, resembling somewhat the gizzard of a fowl, hence its name.

The natural food of the larger and better species, as minnows, young skip-jacks, gizzard-shad, toothed-herrings, and crawfish I found very abundant in all unpolluted streams, but where there were located starch-factories, paper mills, oil-refineries, distilleries, etc., on small streams, all fish-life was absent or very scarce below them. The waste products of such establishments should be run into suitable pits, and much of it could be utilized as fertilizers, by mixing with it other proper material, and in this way become a source of revenue and profit to the proprietors, instead of running to waste and rendering streams unfit for live-stock and poisonous to fishes.

A large river like the Ohio tends to purify itself of foul matter by its strong and steadily-flowing current, where a smaller and

shallower or rockier stream can not do so. If the present laws for the protection of fishes are rigidly enforced, and the poisoning of the smaller streams by the waste products of factories of various kinds prohibited, there is no reason why the Ohio and its large tributaries, as the Muskingum, Scioto, Hocking, and the two Miamis, and the streams flowing into Lake Erie, should not furnish an ample supply of good food-fishes and game-fishes.

LIST OF FISHES OF LORAIN COUNTY, OHIO.

By L. M. McCormick.

Read January 7, 1890.

Family I.—Petromyzontidæ.

1. Petromyzon concolor (Kirtland). Lamprey.

Family II.—Acipenseridæ.

2. Acipenser rubicundus Le Sueur. Rock Sturgeon.

Family III.—Lepisosteidæ.

3. Lepisosteus osseus (Linnæus.) Long-nosed Gar.
4. Lepisosteus platystomus Rafinesque. Short-nosed Gar.

Family IV.—Amiidæ.

5. Amia calva Linnæus. Dog-fish.

Family V.—Siluridæ.

6. Noturus gyrinus (Mitchill). Chubby Stone Cat.
7. Noturus flavus (Rafinesque). Yellow Stone Cat.
8. Ameiurus nebulosus (Le Sueur). Bull-head.
9. Ameiurus vulgaris (Thompson). Long-jawed Cat.
10. Ameiurus natalis (Le Sueur). Yellow Cat.
11. Ictalurus punctatus (Rafinesque). Channel Cat.

Family VI.—Catostomidæ.

12. Ictiobus velifer (Rafinesque). Quill-back.
13. Catostomus teres (Mitchill). Common White Sucker.
14. Catostomus nigricans Le Sueur. Stone Roller.
    Hypentelium nigricans (Le S.)
15. Minytrema melanops Rafinesque. Spotted Sucker.
16. Moxostoma anisurum (Rafinesque). Long-tailed Red Horse.
    Moxostoma velatum (Cope).
17. Moxostoma aureolum (Le Sueur). Lake Red Horse.
18. Moxostoma duquesni (Le Sueur). Common Red Horse.
    Moxostoma macrolepidotum (Le Sueur).

Family VII.—Cyprinidæ.

19. Campostoma anomalum (Rafinesque). Steel-back Minnow.
20. *Chrosomus erythrogaster Rafinesque. Red-bellied Dace.

21. Pimephales notatus (Rafinesque). Blunt-nosed Minnow.
22. Notropis hudsonius (Clinton). Lake Shiner.
23. Notropis megalops (Rafinesque). Common Shiner.
    N. megalops frontalis (Agassiz).
24. Notropis ardens lythrurus (Cope). Red-fin Minnow.
25. *Rhinichthys cataractæ (Cuv. & Val.) Long-nosed Dace.
26. Hybopsis kentuckiensis (Rafinesque). Horned Dace.
27. Semotilus atromaculatus (Mitchill). Common Chub.
28. *Phoxinus elongatus (Kirtland). Red-sided Shiner.
29. Notemigonus chrysoleucus (Mitchill). Golden Shiner.

Family VIII.—Hiodontidæ.

30. Hiodon tergisus Le Sueur. Toothed Herring.

Family IX —Salmonidæ.

31. Coregonus clupeiformis (Mitchill). Whitefish.
32. Coregonus artedi Le Sueur. Lake Herring.

Family X.—Umbridæ.

33. *Umbra limi (Kirtland). Mud Minnow.

Family XI.—Esocidæ.

34. Esox vermiculatus Le Sueur. Grass Pike.
35. Esox lucius Linnæus. Pike; Northern Pickerel.

Family XII.—Anguillidæ.

36. Anguilla rostrata (Le Sueur). Common Eel.

Family XIII.—Gasterosteidæ.

37. Eucalia inconstans (Kirtland). Brook Stickleback.

Family XIV.—Atherinidæ.

38. Labidesthes sicculus Cope. Silversides.

Family XV.—Centrarchidæ.

39. Ambloplites rupestris (Rafinesque). Rock Bass.
40. Lepomis cyanellus (Rafinesque). Green Sunfish.
41. Micropterus salmoides (Lacepede). Large-mouth Black Bass.
42. Micropterus dolomieu Lacepede. Small-mouth Black Bass.

Family XVI.—Percidæ.

43. Etheostoma pellucidum Baird. Sand Darter.
    Ammocrypta pellucida (Baird).

44. ETHEOSTOMA NIGRUM Rafinesque. Johnny Darter.
Bolesoma olmstedi maculatum (Agassiz).

45. ETHEOSTOMA ASPRO (Cope & Jordan). Black-sided Darter.
Hadropterus aspro (C. and J.)

46. *ETHEOSTOMA PELTATUM Stauffer. Shielded Darter.
Hadropterus peltatus (Stauf).

47. ETHEOSTOMA FLABELLARE Rafinesque. Fan-tailed Darter.

48. ETHEOSTOMA CŒRULEUM Storer. Rainbow Darter.

49. PERCA FLAVESCENS (Mitchill). Yellow Perch.
Perca lutea (Rafinesque).

50. STIZOSTEDION VITREUM (Mitchill). Ohio Salmon.

51. STIZOSTEDION CANADENSE (C. H. Smith). Sauger.

Family XVII.—SERRANIDÆ.

52. ROCCUS CHRYSOPS (Rafinesque). White Bass.

Family XVIII.—SCIÆNIDÆ.

53. APLODINOTUS GRUNNIENS (Rafinesque). Sheepshead; White Perch.

Family XIX.—COTTIDÆ.

54. *COTTUS BAIRDI (Girard). Miller's Thumb.
Uranidea richardsoni (Agassiz).

Family XX.—GADIDÆ.

55. LOTA LOTA (Linnæus.) Lawyer; Ling.
Lota maculosa (Le Sueur).

[The above partial list of fishes of Lorain County, Ohio, was communicated to me by Mr. L. M. McCormick, Preparator of Oberlin College. Specimens of all of the species named are preserved in the Museum of Oberlin College. Those marked by an asterisk (*) are additions to my former lists of Ohio fishes published in this journal, and Mr. McCormick has kindly sent specimens of them to the Museum of the Cincinnati Society of Natural History. The fishes were collected in Black and Vermillion Rivers and their tributaries.

I have made a few changes in nomenclature, in accordance with our present knowledge of ichthyology, and wherever this is done I have added the names used by Mr. McCormick as synonyms.

JAMES A. HENSHALL.]

NOTES UPON THE BRAIN OF THE ALLIGATOR.

By C. L. Herrick.

[Read by title February 4, 1890.]

Scientific interest may be said to be fast coming to a focus upon the domain of cerebral anatomy and physiology. For a long time the brilliant failures of the most highly endowed students to find a foothold in this inviting domain have acted as a check upon all but the most audacious or most ignorant. The vagaries of phrenology found their unexpected use as missles to be hurled at the adventuresome explorer who crossed the "dead-line" separating sober study of bone and muscle from the doubtful domain of brain and nerve. It is a very few years since the new science of "microtomy" with its implied improvement in histological technique has wrought a wonderful change. Fortunately, the door thus opened is within reach of such only as have already a speaking acquaintance with science and have had experience enough to sober a too luxuriant fancy. The very intricacy and tedium of the methods of the new science are sufficient shibboleth to debar the indolent and grossly ignorant. Even the great promise from the anatomical side is excelled by the results to be expected from a regenerated psychology. When psychology becomes truly an inductive science—a science of observation—its empyricism may have some content to offer the rational section. Of the two great difficulties to-day besetting the original experimenter, perhaps the greater is the lack of definiteness on the part of psychology. One can gain but the most vague notion as to the processes involved in an excitement of a sensory or motor cortical area. The analysis of a common presentation of sense is so faulty that each man must begin his experiments with a blind groping after the probable sequence of physical and psychical processes before, for example, the presentation of a "red apple" reaches consciousness. The second great difficulty in the successful interpretation of cerebral experimentation results from the shameful lack of positive knowledge concerning the finer anatomy of the brain and central nervous system.

Much has, indeed, been written, but by far the greater part of the work has consisted of the application of the old methods of

coarse dissection upon a somewhat enlarged plane by means of the microscope. The present state of histological technique justifies the hope that we may soon be able to map the important areas of the brain with minute accuracy, even to the details of almost every cell and fibre. It seems to the writer that it is to this end that effort should now be directed, and that no pains will be misapplied which affords us a view of the actual elementary structure of any part of the nervous system.

We recognize with gratification the great progress since 1864, when Reissner could say: "It is not to be wondered at that little has been accomplished in this department, inasmuch as there have thus far been few students of the structure of the brain in general." ("Nervous System of the Anura".) It was only in 1852 when Wyman admitted that "the connection between fibre and cell could never be made out"

Our satisfaction disappears, however, when we find Raue in 1889 calmly saying: "The origins of the sensory nerves are still more or less wrapped in mystery. What has hitherto been taken for granted, viz.: that all the nerves arise from ganglionic cells, and that, therefore, not only sensorial perceptions, but all mental activities, originate by some sort of chemical and molecular action within the cells, seems likely to prove fallacious. If the latest researches of Max Schultze are correct, it appears that the nerve cell is essentially only an enlargement with nucleus and nucleoli, of the axis cylinder; that, therefore, it does not represent the beginning, but is merely an intervening expansion of the nerve in its course."

As will be gathered from the technical portion of this paper, there still remains a great deal to do in the comparative domain in the simpler problems of gross anatomy of the brain of lower animals. It is obvious that in many cases, at least, the solution of the extraordinary complicated structural problems presented by anthropotomy must be reached by a study of the same problems in the simpler terms of the comparative subject.

The present paper is a first contribution to a series of such problems. The somewhat disconnected jottings upon the cerebral anatomy of the Crocodilia have primarily grown out of a desire to test certain conclusions suggested by a study of the brain in mammals. The relative simplicity and the primitive character of the brain of the alligator seemed to make it a fit subject for comparison

with that of the higher types. The important position occupied by these reptiles with relation to their own class and the Sauropsida generally, because of their antiquity, isolation, comprehensiveness, and especially their resemblance to birds in very important structural points, adds importance to otherwise trivial details. It soon appeared that, entirely aside from the problems in the interest of which the investigation was made, the intrinsic importance of the subject warranted a more detailed treatment than at first expected.

The notes, at first made for a special purpose, have, therefore, been extended and connected by subsequent observations in order to secure a measure of completeness and sequence in what must, nevertheless, betray the fragmentary and sketchy origin. The material upon which this paper rests is derived from four small specimens of alligator, none of which exceeded eighteen inches in length, all of which were received through the kindness of friends. Three of these were furnished by Mr. Gray, of the College Hill Conservatory, while a much regretted hiatus was filled through the kindness of Mrs. Stevens, of Columbia.

The methods employed were simple, though, unfortunately, in several cases, accidents prevented the complete success of the operation. The fixing medium in each case was a dilute chrom-acetic acid bath, in which the brains were left for twenty-four hours. This has proven for small brains the most uniformly successful of all media. If care is taken to remove excess of acid, there is little difficulty in staining permanently. The specimen is then placed in fifty, seventy, eighty and ninety per cent. alcohol successively, with intervals of twenty-four to forty-eight hours. The best sections for all purposes were stained in section with aqueous haematoxylin, but the process is tedious and makes it difficult to secure consecutive series. Staining in toto with alum cochineal is excellent for many purposes. The entire brain is placed in a strong solution of the stain from seventy-five per cent. alcohol, remaining twelve hours, and afterward is hardened in alcohol as usual. Alcoholic cochineal and carmine preparations produced only a diffuse and highly unsatisfactory stain, as did the alcohol haematoxylin, so highly recommended. Analine blue-black possesses no advantages over haematoxylin. In spite of experimental difficulties, fairly useful series were made, embracing the entire brain cut transversely, longitudinally-horizontally and longi-

tudinally-perpendicularly. From these the effort was made to spatially reconstruct the several organs and trace the course of tracts. The accompanying drawings are nearly all made with the aid of the camera lucida, and the effort was made to exhibit only what appears in the actual section studied, and to copy, as far as consistent with the small size of the reproductions, the appearance of the section. Thus, instead of generalizing tracts or representing nuclei by a few exaggerated cells, the attempt was made to present as nearly as could be the texture seen with the power used. No liberty has been taken with the outline of sections, so that where they were somewhat oblique the lack of symmetry was faithfully copied.

In no class of vertebrates is our knowledge so limited as in the Reptilia, and, for this reason, the writer labors under some disadvantage. It can not be hoped that the entire range of literature has been examined, though great effort was made to secure all important memoirs.

We have a very accurate description of the topography and external form of the alligator brain by Rueckhard.*

It will, therefore, be unnecessary to go into details of this sort. The difference in age between our specimens and those of Rueckhard may account for discrepancies. The reader is referred to the figures of the entire brain on Plate VII for details.

I.—Gross Anatomy.

1. *The Rhinencephalon.* The olfactory portion of the fore-brain, in this stage, projects beyond the hemispheres by about the combined length of the hemispheres and optic lobes, and forms a double, clavate body. The two lobes, though closely appressed, are quite distinct. The lumen of the crura olfactoria is continuous with the cerebral as well as the rhinencephalic ventricle, and, indeed, there is no sharp line of demarkation. The minute structure differs but slightly from that of mammals.

Wiedersheim says (Comp. Anat., p. 146) "Olfactory lobes seem to be absent in crocodiles only," a statement evidently based on hasty observation.

2. *Prosencephalon*, as seen from above, is broadly oval, and is somewhat emarginate behind for the reception of the optic lobes. A cross section near the front of the hemispheres shows the greatest

*Rabl-Rueckhard, "Das Centralnerven-system des Alligators," *Zeitschrift fuer wissenschaftliche Zoologie*, Bd. XXX, p. 336, 1878.

breadth to be near the dorsal surface, which is gently arched, passing by a gradual curvature into the oblique and gently convex lateral surface, and by an abrupt flexture into the plane median surface. Thus the lower surface is restricted to a narrow ridge passing into the crura olfactoria. The section also reveals the extent of the ventricle, which continues as a narrow cleft within a short distance of the surface from the median lower angle dorsally, then outward, and finally ventrally to a point near the greatest external projection, and thus about two-thirds separates an axial protuberance or lobe from the mantle or cortex. The extent of the ventricle increases toward the posterior until the axial lobe is connected with the mantle only by a narrow isthmus equal to less than a fifth of its circumference, this line of union being limited to the lower aspect. The commissures connecting the two cerebral hemispheres are described beyond. As compared with the adult, the brain in this stage is remarkable for the short globose hemispheres, short rhincephalic crura, and the compactness of the entire brain. The resemblance to an avian brain, except in the cerebellum, is marked.

3. *The Diencephalon* does not reach the surface above, but is enclosed by the over-arching hemispheres and optic lobes. It is bounded anteriorly by the optic chiasm, lamina terminalis, and fissura pallii; above by a membranous covering; posteriorly by the commissura posterior; and below by the tuber cinereum, forming the floor of the third ventricle.

The posterior commissure forms the highest, and, at the same time, most posterior portion of the thalamus. It is over-arched by the anterior protuberance of the corpora bigemina. The connection of the pineal body with the superior commissure could not be detected, though the pillars passing into the choroid plexus from its lateral aspects may represent the pineal crura. The connection of the commissure with fibres from the tænia thalami is very obvious. The connection of the infundibulum below with the pituitary body is indicated in our figures. The latter is an oval body without ventricle or important structural peculiarities. The median or soft commissure separates the third ventricle into two portions, that lying below it passing into the infundibulum. The ventricle is somewhat arched. Back of the foramen of Monro it appears as a narrow cleft, extending upward, as traced backward, then dividing, as above indicated, the upper passing into the ventricle of the

optic lobes; the lower, besides its relation to the infundibulum, extends by the aqueduct of Sylvius to the fourth ventricle.

4. *The Corpora Bigemina* (Mesencephalon) are relatively large, greatly resembling those of birds, and are rather more than half the length of the cerebrum. They are somewhat oblique, but the longer axis is approximately at right angles to that of the brain. The large ventricles of the optic lobes are nearly filled by large semi-oval protuberances from the lateral and posterior walls. They are separated from the ventricles by an inner wall continuous with the inner fibre-layer of the tectum opticum. These bodies are called by Rueckhard *colliculi* of the corpora bigemina. They are the same masses called by Bellonci* *inner protuberances.* He describes them in the amphibians as "containing nerve cells which are arranged in irregularly concentric layers. Nothing indicates the formation of a special, well-localized nucleus." In the birds it is said to be similar.

The considerable size of the nuclei corresponding to the posterior lobes of the corpora quadrigemina may be noted as of especial interest. These are more fully described beyond. These nuclei constitute the *corpus posterius.*

5. *The Cerebellum* (Epencephalon)is unusually large in the Crocodilia, affording an additional resemblance to higher vertebrates, but it is perfectly devoid of convolutions. Its internal structure is exceedingly simple. The form is nearly conical, with the apex directed backward, the cross-sections thus being circular. The corresponding organ in turtles, for example, is a mere flat leaf-like body. Just in front of the base of the cerebellum the roots of the trochlearis may be seen springing from the velum medullare anterius. The connections with the remaining parts of the brain will be discussed later.

6. *The Metencephalon* is sub-rhombic and widely expanded in the horizontal plane, narrowing rapidly anteriorly, especially ventrally, to the union with the diencephalon. The fourth ventricle is only partially covered by the cerebellum. After a removal of the membranous coverings, a series of prominences may be seen upon the base and sides of the ventricle. These mostly mark the site of nuclei at the roots of the nerves V, VIII, X, etc., and are termed tuberculi trigeminorum, eminentia acustica, eminentia vagalis, etc.

*Josef Bellonci: "Ueber die centrale Endigung des Nervus opticus bei den Vertebraten," *Zeitschrift fuer Wiss. Zoologie*, Bd. 47, 1888.

The thickened postero-lateral border of the ventricle is termed the obex, while outside of this is the clava or dorsal column. It is remarkable that a decided asymmetry is not rare in the medulla; thus, in the specimen figured, the roots of the left cranial nerves are much further forward than on the right side.

The oculo-motor nerves spring from a well-defined trigonum interpedunculare, and in other respects the brain does not correspond with the figures of Rueckhard. The transition between the medulla and the cervical portion of the cord is very gradual, so that the demarkation must remain vague.

7. *The cranial nerves.* Considerable pains has been taken to determine the peripheral course of the cranial nerves, but some details, especially with relation to the accessory and sympathetic fibres, remain obscure. The intervertebral expansions of the cord make it easy to identify the position of the roots in that region. The dorsal protuberance corresponding to the position of the sensory root of the first cervical makes the absence of that root the more conspicuous. The spinal accessory with a strand of the vagus apparently supplies the place of the dorsal roots of both the first spinal and the hypoglossal, as indicated beyond, though perhaps theoretical considerations may make it more probable that it is the part representing the posterior fibres of the vagus which has suffered this modification. This branch emerges with the tenth proper from the jugular foramen, but its deeper course is through an osseus path distinct from that of the vagus. The accessory fibres unite with this portion of the tenth, and, though the common trunk is appressed upon the ganglion vagi, no evidence of actual interblending was observed. This trunk gives off a branch supplying the cervical muscles soon after leaving the foramen; the larger portion, however, continues forward, continuing externally with the vagus and glosso-pharyngeal, to form a loop with its fellow of the opposite side below the root of the tongue, giving off various branches in its course. Centrally the accessory seems to extend backward as far as the dorsal root of the second spinal (see Plate VII, Figs. 4–5).

The remaining roots of the vagus unite to form a ganglion vagi of considerable size. Not only does this ganglion contain the fibres of the hypoglossal and glosso-pharyngeal, but it is perforated by the posterior branch of the eighth nerve. The relations strongly remind one of the condition observed by Ahlborn in *Petromyzon.*

What the relation of the eighth nerve may be was not determined, but the lighter color of the acusticus fibres serves to distinguish them at their entrance and exit. The single strand forming the ninth nerve is quite distinct from the vagus roots, and, after emerging from the ganglion vagi, forms a second small ganglion—glosso-pharyngeal ganglion—whence it passes without branches or anastomosis to the sides of the floor of the mouth near the inferior maxillaries. The ganglion vagi gives origin to two vagus bundles.

The first of these contains only pure vagus-fibres and is distinctly barred transversely. It passes candad at some distance laterad from the median line, entering the thorax, and passing over the aortic arch, it dips under the vena cava, pulmonary artery and bronchus, giving off numerous branches to the respiratory and circulatory organs, and continues to the abdominal viscera.

The second of the two vagal strands contains chiefly hypoglossal fibres, and divides half-way to median line, a portion of its fibres passing parallel to the vagus caudad, soon dividing into two strands which anastamose with the sympathetic and form a complicated meshwork; the remainder of the fibres pass under the hyoid cornu and supply the muscles about the head of the trachea and hyoid.

The roots of the tenth extend obliquely along the lateral protuberance of the clavæ, and consist of a variable number of fibres. Rueckhard speaks of fourteen to fifteen, but figures eleven root-fibres. On both specimens studied we found eleven or twelve such fibres, including the posterior pair, which pass to the accessory and are separated by an interval nearly as long as the root area of the remainder from the next cluster.

The *ninth nerve* springs from a point dorsad and anterior to the foremost root of the vagus, and has but two root fibres at its exit. It passes through the jugular foramen.

The *twelfth roots*, on the other hand, emerge from a point ventral to the tenth and through a distinct foramen, entering the ganglion of the vagus from a medio-ventral direction. The hypoglossus forms a rather distinct cluster of nerve roots nearer the median line of either side than the following first cervical. Three subordinate groups of fibres may be distinguished, the most anterior containing two, the following from five to seven, and the posterior, from four to five fibres.

The *eighth nerve* arises by a strong cylindrical trunk which can

be traced superficially dorsally to the eminentia acustica, protruding into the ventricle. It soon divides into two diverging trunks, the posterior of which, as already seen, perforates the vagus ganglion; the anterior was not traced. Beneath the anterior eighth, somewhat ventrad and candad to the main trunk, is the simple *seventh root*. It passes cephalad parallel to the anterior portion of the fifth, behind the orbit, to the facial region.

The *sixth nerve*, situated almost directly ventrad of the eighth, consists of two separate fibre clusters, the anterior one containing three, the posterior two fibres. Its course is the usual one.

The *fifth nerve* preserves the usual relations, its sensory and motor strands entering at once the gasserian ganglion, from which emerges the common trnnk. The division into a superior and inferior branch takes place at once, the inferior division giving off a small branch to the masseteric region, then passing to the inferior maxillary, where it divides, the larger branch perforating the inferior maxillary and supplying its alveoli, the smaller being distributed to the adjacent muscular insertions. The upper branch gives off branches to the eye-ball and passes behind the latter to the facial region, where it subdivides. No special description of the peripheral distribution of the *third* and *fourth* nerves is necessary, as their course seems to correspond closely with that of other vertebrates. The chief hiatus left by Rabl-Rueckhard has thus been filled.

II.—Histology and Description of Sections.

1. *The commissures of the cerebrum.* Three sets of fibres commingle at the level of the anterior commissure (*a*). The uppermost or *callossal band* is well displayed in a transverse section in front of the chiasm (Plate VIII., Fig. 9), as a strongly arched, compact group of apparently commissural fibres dipping downward from the lower inner margin of the median portion of the mantle, forming a sharp upper curvature to ascend to the corresponding portion of the mantle of the opposite hemisphere. Its fibres radiate in all directions, especially anteriorly, and apparently pass chiefly to the ventrical wall of the mantle, but their exact relation to the fibres next to be described must be left for the present undecided. (*b*) A loop crosses from one hemisphere to the other beneath the callosum, which is thought to represent the rudiment of the *fornix*. In close connection with this is a fibre tract which lies approximately parallel to the median fissure, and pursues an

oblique course from behind forward over the arch formed by the callosum. It seems to arise in the region of the small olfactory (?) cells along the base of the brain surface near the ventro-posterior angle, passing approximately parallel to the above-mentioned fibres till lost in the same region of the mantle as those of the callosum. It is not quite certain that there is a considerable decussation of fibres here. The tract is in every way comparable with the direct fibre zone, ascending from the more anterior portions of the same basal region to the median mantle lobe, except for the apparent decussation.

(*c*) A third set of fibres lying at a lower level passes directly across in a horizontal plane from the regions of the thalamus, where the peduncular fibres begin to radiate toward the axial lobe. The fibres are certainly commissural, rather than a decussation, and in sections stained especially for the fibres these can be traced parallel to the radiating fibres of the peduncles and not into the descending tract. This tract can be homologized with little hesitation with the *anterior commissure*, being a true commissure of the thalamus.

The commissural bands thus described have been variously interpreted. Stieda has called this complex "corpus callosum," to which Rabl-Rueckhard responds: "These fibres can not be considered as the anterior commissure, since that organ is always chiefly a commissure of the axial lobe, and has nothing to do with the mantle. Whatever homologue is sought in more highly organized brains must, at least, be a mantle commissure. Such a structure is afforded by the fornix, on one hand, and the corpus callosum on the other. It is of especial interest that Stieda, in his work, "Neber den Bau des centralen Nervensystems der Schildkroete," found an entirely analogous body in the same region, as well as a second one passing more nearly transversely, which loses itself in the basal portion of the axial lobe. Stieda applies to the former the term "callosal rudiment." If he uses the term as including both the callosum and the fornix, covering the median mantle commissures of the cerebrum of higher vertebrates, nothing can well be opposed to its employment, although it is, perhaps, an unfortunately ambiguous expression. If, however, it is intended by Stieda to homologize it directly with the corpus callosum, to the exclusion of the fornix, I must dissent, for the callosum originates later and higher than the fornix, even though the two are united by the lamina genu. Considerable difference of opinion exists as to the

course of the fibres in these bundles. Orr (*Journal of Morphology*, Vol. I., 1887), says of the commissures in the lizard: "The superficial position of these commissures, anterior, superior and posterior, their similar connection with the lateral bands and their relations to the constrictions of the brain, suggest at this period a striking homology between them." This remark grows out of a conjecture that the anterior, as well as other commissures are continuations of the primitive lateral longitudinal fibres. Osborn (*Journ. Morph.*, Vol. II.,) observes: "It is true that the fibres beneath the fore-brain branch from the lateral longitudinal band much as do those passing to the region of the other commissures; but I can not at present adopt his view that they represent the anterior commissure, because the development of this commissure, as I have found it in the Amphibia and Mammalia, indicates that it is strictly commissural, and not the decussation of a longitudinal tract. Immediately beneath the anterior commissure in the amphibian fore-brain, I have observed fibres decussating from the longitudinal bundle to the opposite hemisphere, which probably represent those attributed to the anterior commissure by Orr."

From what has been already said, it is plain that the alligator gives us a clue to the discordant statements above quoted. All three of the transverse systems are present, and sustain a relation entirely similar to that in mammals, making the necessary allowances for topographical modifications. The comparative perfection of the corpus callosum is especially important, and indicates the impossibility of making hard and fast lines of distinction between vertebrate classes upon the basis of the presence or absence of major structures in the brain.

(*d*) *The superior commissure* and *taenia thalami optici*. This bundle is of great importance, from the direct connection between the superior surface of the diencephalon and the cortex of the hemispheres. It is doubtless of sensory function, and may be traced from the postero-lateral regions of the cerebral cortex medianly and upward, thence across the interval between the hemispheres and the thalamus, to the latter. Its fibres stain deeply and are comparatively large. They finally enter the ganglion habenulæ or its apparent homologue, while other portions pass upward and cross in a well-defined commissural band. In the alligator, no evidence of the further extension of the fibres of this region to a pinneal body could be discovered. . It appears probable that some fibres

from the taenia thalami enter the corpus geniculatum. The superficial and tortuous path of the tract makes it hard to follow. (Compare Plate VIII., Figs. 10–16; Plate IX., Figs. 6, 8, 9; Plate XV., Figs. 4, 5 and 7).

Osborn (*Jour. Morph.*, Vol. I.) describes this bundle as follows: "It divides into two distinct bundles, one of which descends into the inner mantle of the hemispheres, and finally disappears, after bending around the inner portion of the mantle. The second bundle descends directly along the outer wall of the thalami. One fact militates against our considering the commissures as a purely decussational system; that is, the bundle entering the hemispheres is larger than that entering the thalami." In the alligator a number of fibres leave the bundle as it is about to pass into the hemispheres turning backward, but their further course was not traced. Comp. Ahlborn ("Untersuch. u. d. Gehirn d. Petromyzonten," p. 285).

(*e*) *Meynert's bundle* is a bundle extending from the region below the superior commissure, and passing obliquely backward and ventrad near the median line, to an indistinct ganglionic mass near the exit of the third nerve. It would appear that this ganglion corresponds to the ganglion interpedunculare of authors (Plate IX., Fig. 9).

(*f*.) The ascending fibres of the *inferior commissure* lie parallel to those of the tractus opticus for some distance, but their further course was not traced.

(*g*). The *posterior commissure* is well seen in transverse sections. In longitudinal sections a strong bundle of fibres springing from the region of the commissure passes ventrad to unite with ascending peduncular tracts, with which it passes apparently toward the cerebrum. Much remains to be done in this portion of the brain.

(*h*.) The *median commissure*, as elsewhere shown, is but an adhesion of the walls of the third ventricle at the bifurcation, with few fibrous connections.

2. *Microscopic structure of olfactory lobes.* The same structure is observed in the olfactory bulb as in other vertebrates, and only a few slight modifications need be mentioned. Sections through the olfactory bulb display an outer fibre-zone passing into the tortuous glomerular layer, which is separated by a homogeneous or gelatinous layer from that containing the ganglion cells. The irregular,

angular form, deep staining, and prevailingly peripheral direction of the apical processes, as well as the relatively small but variable size of the latter, are the most important features. In mammals the ganglion cells are pyramidal, with irregular bases toward the periphery, and with long, apex processes directed centrally. The structure of the olfactory lobes in lower vertebrates merits more study. (Compare *Bul. Denison University*, Vol. V., for figure of corresponding structure in Arctomys.) Within the narrow zone of ganglion cells is a homogeneous belt, with only scattered cells, separating it from the mass of more or less concentrically arranged cells making up the bulk of the centre of the bulb. The large ventricle is clothed with deeply staining epithelium. (Plate IX., Figs. 6 and 6*a*.)

A peculiarity worthy of notice is the existence of a remarkable olfactory fossa, which does not appear superficially, but is readily seen in longitudinal median sections of the bulb, in which it appears as a pit-like depression of the ganglionic layer, filled with a special mass of the glomerular zone, and which is connected with the fibre layer by a special tract.

The inner nucleary mass extends some distance into the crura, but is then supplanted by a cell-structure like that typical of the cerebrum. In fact, two cerebral elements enter nearly simultaneously. The pyramidal deeply-staining elements predominate, while the flask-like pale cells are generally nearer the center than the others, or occupy a median position with reference to the combined crura. The longitudinal axes of these two varieties of cells are not parallel, even in the crura. All evidence of special olfactory structure disappears long before the union of the latter with the hemispheres. As the crura approach the cerebrum the olfactory fibres collect in the lower portion, and the region becomes permeated with minute multipolar or bipolar cells like those which occur in the hippocampal region of higher vertebrates. These stain deeply, and are very irregularly distributed. The olfactory fibres gather in the lower median angle as the tract passes into hemisphere, and they can be traced in one tract candad and dorsad to about the level of the anterior commissure, whence it may be conjectured that fibres proceed to the cortex of the calloso-marginal or occipital region. It is probable that other and important parts of the tract are superficial on the inferior and lateral basal areas collecting at the postero-basal margin, and sending fibres by

way of the fornix to the calloso-marginal region. It is uncertain whether the fibres from this region to the tænia thalami have anything to do with the olfactory tract, though this is not excluded by observation.

3. *Microscopic structure of the cerebrum.* The natural division of the cerebrum into an axillary and mantle portion, is likewise very convenient for the purpose of description of the nervous elements. Attention is again called to the reason for regarding these two regions more closely related than either is with the diencephalon. The corpus striatum, as such, does not exist in the alligator, but the major part of the cerebrum consists of what Rabl-Rueckhard called axillary lobes (Stammlapfen). The axillary lobes consist of a rather homogeneous mass of cells, and has a contour similar to that of the entire hemispheres, but is covered by a mantle which embraces it on all sides except behind, and is separated from it on all sides except antero-inferiorly by the ventricle, which is exceedingly narrow. The axillary lobes are, therefore, the immediate cellular envelopes of the direct extension of the peduncles. The mantle portion is exceedingly thin, and presents little opportunity for variety in structure. There is, however, a marked diversity in the cellular elements entering it, as will be gathered from descriptions of the sections.

Three distinct kinds of cells can be detected in the mantle; one characteristic of the superior and anterior regions, another of the occipital, median and posterior-lateral regions, and a third about the ventro-basal regions or hippocampus. From analogy these may be assigned to motor, psycho-sensory and special olfactory functions respectively. The axial lobes likewise have two sorts.

The pyramidal cells which were first above mentioned, stain deeply, have small nuclei, and have a long apex-process generally directed obliquely toward the periphery, and several basi-lateral processes. No central basal process such as described by Meynert was seen. These motor cells can be traced into connection with the basal prosencephalic tract (continuations of the peduncles). Indeed, similar cells can be followed to the diencephalon. The second variety of cells is flask-shaped or balloon-shaped, and has a slight power of precipitating stains; and is further characterized by the large clear nucleus or perinucleary space. Such cells are distinctive elements over the posterior and median parts of the cortex. Especially constant are they in the median wall. (Fig. 9, Plate

VII.) The great bulk of the axial lobes—that portion which protrudes into the ventricle—is filled with similar flask cells, but these are curiously clustered in groups of two or multiples of two. (Plate VII., Figs. 7, 8.) The evidence that these cells are undergoing rapid increase by fission in this young animal is very conclusive. All stages of the process may be observed. It may be suggested that, if in the case of young animals this part of the brain is most actively multiplying cells, it is possible that the growth of the mantle (in which there is little material for rapid growth) may be in some way associated with this proliferation of cells, resulting in the increase of the mantle from its margins, as though the material were pushed up around the margins of the ventricle by rapid growth within.

The connection of this portion of the axial lobes of the cerebrum seems to be with the superior or sensory longitudinal tracts of the peduncles. In addition to the tracts above mentioned, the tænia thalami, springing from the basal region and passing to the habenulæ, form a sensory link between the thalamus and the cortex. It is noticeable that the cells associated with this tract, even in the thalamus, are of the flask variety. It is perhaps advisable to here discuss the structure of the actual sections.

Details of transverse sections of the hemispheres. The description already given, with the figures of Plate VIII., will sufficiently illustrate the relations of the ventricles, etc. The cellular structure of the cortex varies little from section to section. There are four regions, each with its typical form of cell, visible in cross sections of the anterior and median parts of the hemisphere. The dorsal and anterior portion of the median cortex contains pyramidal, irregular, multipolar cells of the sort represented in Fig. 11, Plate IX. The whole lateral aspect is occupied by a dense layer of cells of nearly the size, but of different appearance from the last. They resemble those figured on Plate VII., Fig. 12, being rather flask-shaped, with large nuclei and few processes. Although at one time suspected that different axial position might account for the different aspect, this seems unsupported by observation.

A third cell-clustre, which occupies a relatively small area anteriorly, but increases caudad, occupies the lower median portion of the mantle. It consists of flask-like or sensory cells with fibres which can be traced to the tract leading directly ventrad to the ventral median portion of the posterior part of the brain, *i. e.*, the

hippocampal region, Fig. 8, Plate VIII., and seems to embrace the continuation of the olfactory tract. The tract connecting the median flask-cell area with the small multipolar cells of the lower cortex, continues forward more than half the length of the hemispheres, and its fibres pass chiefly, but not solely, to the ventricle side of the cell layer. As these flask-cells are traced backward they increase in number, and underlie the dorsal motor cell-layer upon the occipital region.

The fourth cell-area occupies the ventral or inferior aspect, and consists of small multipolar, very irregular, and deeply stained cells, reminding of the cells of the olfactory lobe. These cells are irregularly clustered as in the corresponding region of mammals. The connection with the third area has already been noted. The axial direction of the cells is not uniform, but the apical processes of the pyramidal dorsal (motor) cells are mainly peripheral; elsewhere the cortical belt is so thin that the cells are nearly parallel to the surface, and the relations are difficult to make out. It seems, however, that the axial positions of the two principal varieties are never parallel.

Description of a section through the anterior commissure. The section (Plate VIII., Fig. 9,) passes through the chiasm, and exhibits the anterior part of the thalamus where it narrows to form the peduncles of the fore-brain. The chiasm consists of fibre clustres interlocking as the fingers of the folded hands. The fourth ventricle has a transverse expansion above the chiasm, and extends upward as a narrow slit to the anterior commissure. The region dorsad to the lower expanse of the ventricle is crowded with small angular cells of the olfactory type, and seem to be connected with the dense latero-basal clusters by fibre tracts. From this region there ascends to the commissure a definite tract passing through the loop formed by the callosum. The cells on either side of this tract dorsally are of the pale, flask-shaped type. The commissura anterior consists here of a transverse band of distinct fibres passing to the part of the peduncular fasciculus where fibres are radiating outward to all parts of the axial lobe, into which its fibres also seem to pass. The ventricle is obviously composed of two portions, an outer and a median. The outer describes about a semi-circle, extending from the supero-median portion to the infero-lateral, separating a rather uniform thin mantle zone, which is, however, thinnest laterally. The remaining median part of the

ventricle is concave toward the surface, and separates a thick portion of the mantle, corresponding in some respects to the anterior portion of the ammons horn. Its cellular elements resemble those of the adjacent parts of the axillary lobe.

A very noticeable layer of large flask-cells occupies the median part of the median mantle segment. These cells, corresponding to cerebro-sensory cells of higher animals, have their apical processes almost uniformly peripheral, and from the basal blunt extremity fibres can be traced to a union with the tract along the ventricle. The course of the apex fibres can not be traced because of the obliquity of the cell axis. As the layer is traced to the dorsal surface, cells of the other type suddenly appear. These multipolar pyramids are somewhat larger, have peripheral apex-processes, but are apparently directed in a direction contrary to the previous set, as determined by focusing. This type of cell-structure extends entirely around the mantle, the cells becoming parallel to the surface in the thinner portions (some doubt remains as to the existence of lateral flask-cells). The superficial part of the mantle is occupied by fibre tracts, apparently extending longitudinally. Near the ventral surface are gathered great masses of small multipolar angular cells, which were supposed to be related to the olfactory fibres in some way.

Passing to the thalamus portion of this section (Plate VIII., Fig. 9,) we notice that at this point the peduncular fibres diverge into the hemispheres, the ventral column passing directly forward and seeming to afford outlet for the motor cells of the dorsal surface. The upper or descending tracts radiate largely to the axial lobes. A pair of median prominences from the peduncles here arise to meet the descending median portion of the mantle, as best seen in longitudinal section (Plate VIII., Figs. 10, 10*a.*; Plate IX., Fig. 8).

A large number of fibres collect in the thalamus from the basal parts of the prosencephalon ; these cross the peduncular bundles (Plate VIII., Figs. 10, 10*a.*, tr. t.). The fibres of the tænia thalami (t. th.) begin to collect to form a bundle just exterior to the peduncular tracts. This bundle passes backward (Plate IX., Fig. 9,) and crosses to the thalamus (Plate XV., Figs. 4, 5 and 7) and ascends the latero-frontal aspect of the thalamus to the region of the superior commissure (Plate VIII., Figs. 11–16). The source in the cerebrum of this tract has not been made out with certainty,

but it was conjectured that it arises from a tract of the postero-basal portion of the cortex near the ventricle and represents the posterior sensory area.

In sections still farther back it appears that the posterior fibres from the anterior commissure cross the peduncular bundles dorsally without coming into any relation to their fibres. The system seems to be purely commissural (Plate VIII., Fig. 10). In sections farther back (Fig. 12) the tænia thalami reach a point near the summit of the thalamus (habenulæ), and the optic tracts can be traced upward along the surface.

4. *Minute structure of the diencephalon and mesencephalon.* Several details of the thalami have already been given, and further description of the region of the infundibulum is added in connection with the optic nerve.

In transverse sections, behind the anterior commissure (Fig. 11) a considerable accumulation of fibres from the antero-central part of the thalamus collects to form a strong bundle.

Still farther back fibres from the habenulæ converge caudad and ventrad to form Meynert's bundle. In sections caudad to the above (Fig. 14) the soft commissure, or commissura media, appears. It is simply an adhesion, with few transverse fibres. At this level fibres converge from above to the large oval corpora geniculata (Figs. 14–16). A small but definite fibre tract passes from the summit of the corpus geniculatum to the gray matter about the superior commissure. The superior commissure is seen in this region as a small transverse band at the very summit of the thalamus. Its relation to the tænia thalami and the apparent absence of pineal crura has been already noticed. The posterior commissure is in part buried in the substance of the thalamus at its juncture with the optic lobes, to which latter it properly belongs. Fibres from this region can be traced ventrad near the median line to the ascending pyramids, where they seem to turn cephalad (Plate IX., Fig. 8, t. r. p. c.). Back of the posterior commissure a well-marked bundle of fibres descends from the corresponding region or lateral aspects of the colliculi between the optic lobes, on either side the aqueduct, to a decussation below the level of the oculomotor nucleus (Plate XII., Fig. 2).

For additional data, we may examine longitudinal-perpendicular sections near the middle of one of the hemispheres (Figs. 6–8, Plate IX.)

In Figure 6, which passes nearly through the middle of one of the hemispheres, the large size of the axial lobe is obvious, the lateral band of olfactory fibres appears at (*o*) and, near it, the crowded cells of the deeper parts of the crura olfactoria. The tænia thalami connecting the posterior part of the mantle with thalamus and superior commissure are only slightly apparent. The thalamus is not as well separated from the axial lobe of cerebrum anteriorly as nearer the median line. Observe the sudden deflection of the peduncular fibres as they enter the mesencephalon. The transversely cut fibres of the posterior commissure are seen. Back of the chiasm and dorsad to it are the deep-colored fibres whose course can be best followed in transverse sections. The ventricles of the optic lobes are large and partly closed by the forward projection of the colliculi, which are composed of densely cellular gray matter, and are separated from the ventricle by a definite stratum of the same nature as the inner portion of the tectum opticum. Back of the optic lobes are two prominences upon peduncles passing to the medulla, which the section discloses as well-defined nuclei intercepting most of the fibres from the inner stratum of the optic lobes. These nuclei are very large and have cells of the flask variety. These prominences (*corpora posteriora*) are homologous with the posterior corpora quadrigemina of Mammalia. It will be interesting to compare the relations of the parts seen in longitudinal section of the mesencephalon of the alligator with the same parts in other vertebrates. The colliculi (col.) of the optic lobes are proportionally as well developed as in the frog. The corpus posterius, of Bellonci (c. p.), is large, and obviously receives the great bulk of the fibres from the inner stratum of tectum opticum or colliculi. There seem likewise to be fibres from the sensory root of the fifth nerve entering it. Its relations are remarkably similar to those in birds. The embryo of the fowl at fourteen days has much such a prominence as appears in the alligator. The lizard (*Podarcis*) has less resemblance in this respect than the aves. The alligator brain very fully substantiates Bellonci's statement that the corpora posteriora are homologous with the corpora quadrigemina posterior of mammals. He says: "The corpus posterius, which is so closely connected with the corpus opticum, is, so far as structure and development are concerned, more closely related with the hind-brain than with the mid-brain. The nucleus of the corpus posterius is developed in the lateral transition region between

the middle and posterior brain vesicles." Josef Bellonci, "Ueber die centrale Endigung des nervus opticus bei vertebraten," *Zeits. Wiss. Zool.*, Bd. XLVII., p. 37.

In sections somewhat nearer the median line are the apparent homologues of the corpora geniculata thalami (Plate IX, Fig. 9, c.gn.) In more lateral sections the division of the optic tract into fascicles which pass to the anterior, lateral and posterior surface of the tectum opticum are shown, while other minor bundles seem to pass back of or through the corpora geniculata. No fibres of the optic tract reach any other locus than the tectum directly, so far as observed. The greatest obscurity still prevails as to the structure and function of the tectum opticum. There remains no doubt that much the greater part of the fibres from the optic tracts end in the tract constituting the superior layer of the tectum, but in spite of almost perfect sections through this region in several directions, the essential structure remains obscure. It seems exceedingly probable that the function is that of internal analysis, somehow corresponding to the external analysis in the retina, to which its structure is very similar. The columnar compartments set off by pillars of connective tissue and containing oval or globular cells, resemble the retinal structure obviously. Plate XII., Figs. 8, 9, indicate the most important relationships. The nervous elements can scarcely be distinguished from the connective. Among the latter are fusiform deeply staining cells, which have been described as the true nervous elements of the tectum, but which are almost certainly the inoblasts of the connective pillars of the tectum.

On the ventricle side these pillars arise from the intervals between the large epithelium cells, and continue without interruption to the outer surface, even intersecting the superficial tract. Near the ventricle are several concentric rows of flask-cells mingled with Deiter's corpuscles. Near the median line these concentric rows fuse and are associated with enormous cells, much larger than any elsewhere in the brain, and more nearly resembling the Perkinje's cells of the cerebellum than any other type. These cells have their processes directed peripherally. In the columnar compartments above mentioned, there are many Deiter's corpuscles as well as the oval or flask-cells described. It is uncertain whether the pyramidal or irregular multipolar cells among the others are really nervous, and if so, whether they are related to those previously described or not. The central fibres collect in a tract near the

ventricle, and some of them, at least, pass to the posterior or inner thinned part of the tectum, and thence to the colliculi. The structure of the colliculi is instructive. The whole mass is an intricate complex of cells and fibres. The cells are of two sorts, the smaller being of the flask variety, and constitute the great bulk of the contents of the colliculi; but here and there are large pyramidal cells twice the length of those previously mentioned, (Plate XV., Fig. 9). Although described as pyramids, these cells are rather magnified flask-cells in appearance. As above stated, it seems all but certain that the internal fibre zone of the tectum enters the colliculi; the fibres uniting with the flask-cells. The fibres from the colliculi seem to descend to the level of the ascending peduncular tracts, and to pass with them to the cerebrum. It is not possible at present to determine whether the tract from the optic lobes to the corpus posterius issues from the colliculi or from the inner zone of the tectum, without having entered that body. There are some hints of the essential unity of these two bodies, and it may be that they represent but severed portions of an originally simple body. (Plate IX., Figs. 4, 6 and 9.) In the deeper layers of the tract connecting them, is a loose nucleus of large, very irregular cells resembling those of the anterior cornu of the cord, but very elongate. (Plate XV., Fig. 8.) The close relation between the optic lobes and the roots of the third and fourth nerves, and a possible connection between the corpus posterius and the roots of the sixth, give us the only clue to the reciprocation between them which we at present possess.

5. *Structure of the cerebellum.* The cerebellum is comparatively simple in microscopic structure, and as little attention could be given to it in this connection, it may be dismissed with a reference to the figures (Plate XIII., Fig. 11.) The accumulation of so large a number of nutritive and formative cells in its central portion, the great vascularity of the mass, the simplicity of arrangement and single layer of enormous discharging cells peripherally, and the peripheral tracts, all seem to favor the current theory that that organ is a storehouse or generator of undifferentiated nervous force at the the disposal of certain distributing centers. One of the smallest and best defined tracts is one passing to it from the optic lobes. The longitudinal sections passing through the peripheral part of the tract of the fourth root, display this fibre bundle, and enable one to trace it into the crura cerebelli.

The girdling fibres of the medulla passing to the cerebellum (or those representing the pons) require more careful study. Our sections suggest that they are of two sorts. First, such as springing from lateral regions of multipolar cells in the medio-ventral portion of the medulla, pass directly dorsad to the decussation on the roof of the fourth ventricle, thence to the cerebellum; second, those which may have their origin in the same multipolar cells, but pass to the raphe, where they discussate; and then forming bands of fibres corresponding to the pons fascicles of higher vertebrates, pass into the postero-lateral crura of the cerebellum. Both sets of fibres were traced to the median portion of the organ, where they pass through the nucleary zone, radiating to the Perkinje's cells, whose processes connect with the superficial fibre zone. No information concerning tracts connecting the medullary nuclei with the superficial fibre zones of the medulla was collected.

The study of the tracts and nuclei peculiar to the medulla must be for the present deferred. It is hoped to discuss these points in connection with the study of other, especially lower, Sauropsida.

6. *The minute structure of the nuclei of the cranial nerves.*

(1.) The *olfactory* has been already described.

(2.) The *optic nerve* tracts may be most conveniently studied in connection with a series of horizontal sections (Plate X) in connection with the transverse. A section through the infundibulum and tuber cinereum at a lower level than the chiasm shows that the oval body protruding from the under surface of the thalamus has a structure similar to that of the tectum of the optic lobes. The epithelium lining the cavity is composed of elongate fusiform cells, which give off processes radiating toward the surface, or, better, their investments are thus produced. It has sometimes seemed to me that these, instead of being mere threads, form a series of more or less completely enclosed columnar compartments, continuous from the ventricle to near the periphery This arrangement is a primitive one, and is quite the rule in the cortex of lower animals, and remains in its primitive form in the retina, tectum opticum, tuber cinereum, and elsewhere in the higher animals.

At a considerable distance from the ventricle is a mass of ganglion cells which are arranged in more or less regular concentric rows and also preserve the concentric arrangement. These, for the most part, have well-defined peripheral and basal processes, and are fusiform or pyramidal in shape. Whether these cells are

united within the columns or not has not been determined, but they seem never to communicate laterally. In the zone separating this ganglion layer from the ventricle are only a few nutritive cells, while outside the cellular zone are only sparsely scattered cells of the same fusiform type. The peripheral fibres of these ganglionic chains can be followed no better than the central ones, but appear to collect to form a tract communicating with the commissure above the optic tract.

A section of a somewhat higher level cuts the chiasm, showing the decussation to be complete, yet, as seen in other sections, the fibres intercross like the fingers of folded hands. The fascicles of the optic nerve have irregular sheaths of connective tissue fibres detected by their stained inoblasts. The lymphoidal cells remaining are few as compared with those of other vertebrates examined. (See Plate X., Figs. 7, 8.) The commissure consists of thick, dark fibres forming its most conspicuous portion, and having, apparently, no connection with the tuber, but extending upward approximately parallel to the optic tract. Behind and above these are more delicate fibres, apparently derived from the ganglion of the tuber. These may be the fibres called by Bellonci "fibræ ansulatæ," but instead of being thick and prominent, as compared with those of the inferior commissure, they are less conspicuous.

It is not difficult to trace the optic tracts upward through successive horizontal sections. The tract divides into several minor portions, some of which reach the tectum opticum on the anterior surface, some on the lateral, and some on the postero-lateral aspect of the tectum. The fibres spread out on the superior surface and turn abruptly downward through the curious columnar structure of the tectum; the emerging fibres converge to the posterior and median portions to enter the colliculi.

The ultimate course of the fibres of the inferior commissure was not discovered, although the dark fibres are followed upward with the optic tracts to near the base of the optic lobes. Some fibres of the optic tracts pass through the corpora geniculata, but pursue their further course to the tectum opticum. No fibres from the optic tracts directly to the cerebrum could be seen. (Plate X., Figs. 3, 4, 5, 6; also Plates VIII. and IX.)

(3.) The *oculomotor nerves* emerge from a point upon the ventral surface nearly midway of the mesencephalon. The roots spring from a well-defined trigonum interpedunculare. The course of

the fibres within the brain is quite short and direct. The roots break up at once into about twenty bundles, which enter obliquely towards the median line, but very nearly in the frontal plane. These fibre bundles may be separated into a number of groups, which, however, are not well distinguished, and lie in the lamina perforata posterior of either side. They can be traced dorsally to a nucleus of large, nearly globular or polygonal cells with large nuclei, forming a laterally-compressed aggregate on either side the Sylvian aqueduct, extending upward and forward with an irregularly ovate outline.

A frontal section at the level of the third nerve passes through about the middle of the colliculi (lateral projections of the ventricles of the optic lobes.) (See Fig. 3, Plate XII.)

No trace of a decussation of the fibres of the third nerve could be discovered.

On either side of the nucleus of the third nerve is a cluster of multipolar cells with three or more acute prolongations, which may be traced some distance towards the lateral margins. Although the greatest prolongation is in the horizontal transverse direction, yet horizontal sections show that they also connect with longitudinal fibres obliquely forward and dorsad and backward and ventrad.

An interesting band of coarse fibres can be traced from a decussation below the aqueduct, obliquely upward across the tracts of the third roots in a gently arched path to the extreme lateral borders of the nucleary zones at the angles of the ventricles of the optic lobes. Here the fibres seem to pass to the colliculi with those from the tectum opticum. Whether these fibres are the paths of stimuli from the optic lobes to third root regions can not be determined at present. (See Plate XIII , Fig. 9.)

(4.) The *patheticus* (trochlearis) nucleus lies caudad and somewhat dorsad to that of the oculomotor. Its principal bulk lies in the frontal plane, passing a little cephalad to the posterior margin of the optic lobes. The fibres extend caudad and laterally, and then curve to a prominent decussation just cephalad to the cerebellum.

(5.) *The fifth nerve.* The relations of the large and complex trigeminal nerve have been imperfectly made out. There is, however, no difficulty in identifying the main motor nucleus, which is reached by a strong direct fasciculus from the root, and occupies a special protuberance into the fourth ventricle, which lies ventrad

and cephalad to the eminentia acustica, and may be called eminentia motoria trigeminalis. The cells are of large size and of the strict pyramidal form, affording a typical illustration of a motor cell. An apical process from each cell, directed obliquely peripherad, gives rise to a root-fibre, while the basal or proximal extremity gives origin to two or more fibres, one of which (the stronger) appears to pass to the raphe.

Other disperse motor clusters may probably be considered as forming a part of the trigeminal motor system.

The sensory roots can be traced with difficulty. Large gray masses near the exit of the nerve, especially dorsally, are probably the sources of some of the fibres. The cells are of a small variety of the flask type. Some fibres were traced to the corpora posteria, or large ganglion masses in front of the cerebellum. A large tract leads into the peduncles of the cerebellum, thence to the median radiating fibre tracts. In horizontal sections it seems that fibres pass from the ventral longitudinal bundle to the fifth nerve, but of this no absolute evidence was secured. (Compare Osborn, "Amphibian Brain Studies," pp. 67–69.)

(6.) The *sixth nerves* are very small and insignificant. The tracts can be traced dorsad to the very floor of the ventricle, where is a very inconspicuous nucleus, in essentials resembling that of the third nerve.

(7.) The *facial nerve*, if correctly identified, has a small definite motor nucleus lying below the level of the fifth, and consisting of fusiform and elongate pyramidal cells in a clustre, with the axis directed toward the root. The position is ventrad and caudad to the great nucleus of the fifth, and has a spindle shape. The cells stain deeply, and the nucleus, while small, is remarkably prominent and well isolated. The fibres have a direct course to the root. The latter fact casts discredit upon the identification, and suggests the possibility that we are dealing with a divergent member of the trigeminal series. In that case the seventh roots were not found, and the corresponding nucleus is absent, or is to be sought in the cells about the lower part of the olives. In the latter case the genu of the tract should have appeared in our different consecutive series, as they were carefully examined with this in mind. A dorsal root of the seventh was only provisionally identified as an ill-defined dorsal mass of flask-cells near the ventricle.

(8.) The *auditory nerve* has two somewhat distinct but adjacent

nuclei, which are the most obvious cell-clusters of the medulla. These lie in the eminentia acustica, or great dorsal and median projections of the walls of the fourth ventricle. The main nucleus is in the caudad or lower division, which contains a very large aggregate of flask-cells. The nucleus is more or less concavo-convex or lenticular, and lies next the ventricle. The apex-processes of the cells are connected with fibres passing medianly to the raphe, from which point their distribution can not certainly be traced. The blunt peripheral portion is connected by afferent fibres, with the roots of (probably the cochlear branch of) the auditory nerve. The second nucleus lies peripherad to the first as well as cephalad, and is composed of two or more strata of more elongate fusiform and larger cells imbedded in a compact gray gelatinous mass. The course of the fibres centrally is the same as in the other nucleus, while peripherally they may enter the branch to the labyrinth. (Plate XV., Fig. 2.) The fact that the apical process is central in these and other sensory cells, and peripheral in motor root cells, is adverted to beyond.

(9, 10.) The ninth and tenth nerves may be considered together. Their nuclei are closely associated upon the upper lateral portion of the clava. The *glosso-pharyngeal* springs from a point a little dorsad and cephalad to the others, and consists of a single clustre of fibres, which pass medianly to the gray matter about the ventricle cephalad to the nucleus of the tenth. The ninth nerve may be in this case purely motor at its origin.

The tenth nerve, with its numerous roots, forms a continuous series nearly the entire remaining length of the medulla, except for a considerable hiatus separating the last cluster of two roots from the anterior fibres of the tenth. It may be suggested that the above-mentioned separate fibres are possibly the homologue of the sensory roots of the twelfth nerve. The fact that the nucleus lies dorsad to that of the twelfth in the same frontal plane, and that is at least chiefly sensory, while the latter is certainly motor, is a curious coincidence when taken in connection with the apparent suppression of the dorsal roots of the first cervical nerve. The nucleus of the tenth is elongate, lying above the canalis centralis, and near the median line. The cells are less than half the size of those of the twelfth, and are largely flask-cells with the apex median, and giving off direct fibres, which leaving the blunt extremity ascend, and then pass transversely to the roots. In some parts there seems to be a mixture of pyramid and flask cells. (Plate XIII.)

(11.) The exit of the spinal accessory roots can be readily found by means of the groove from which they spring. If our observation be correct, the root fibres can be traced to a ganglion of rather diffuse cells of the same type as those of the adjacent hypoglossal nucleus. The fibres pass directly laterad to the root.

(12.) The hypoglossal nucleus resembles the cell masses of the central cornu of the cord. The cells are large and multipolar, and occupy a variable area ventrad and laterad from the canalis centralis in tolerably definite ventral cornua.

The fibres are easily traced to this nucleus, but no actual union between fibres and cells was seen; perhaps because of the obliquity of the former.

In conclusion, it may be mentioned that the apparent homologues of the olivary bodies lies caudad from the crura of the cerebellum, and are of conical form with the longer diameter in the antero-posterior axis.

In horizontal section the body appears circular, and extends from near the ventral surface to a high level. The structure is a dense mass, containing many very small flask cells. From these masses fibres ascend to the level of the ventricle. Ventral to these bodies are small clustres of larger cells apparently connected with the same tract. These latter clustres were at one time considered the roots of the seventh, but no genu of the tract could be found by careful search.

Beneath the cephalic extension of the eighth nucleus, a transverse section exhibits many large multipolar cells, which are rare elsewhere in the anterior part of the cerebellum.

7. *Measurements of an alligator brain.* The following measurements may serve instead of an extended discussion of the proportions.

From chiasm to end of olfactory lobes, 16 mm.
From chiasm to front of hemisphere, 6.5 mm.
From chiasm to posterior end of pituitary body, 8 mm.
Combined width of hemispheres, 15 mm.
From chiasm to anterior roots of nerve VI, 10 mm.
Greatest width of medulla, 10 mm.
From chiasm to anterior root of XII, 15 mm.
Combined length of cerebrum and olfactory lobe, 20 mm.
Median length of optic lobes, 5.5 mm.
Median length of cerebellum, 6 mm.
Width of cerebellum, 8.5 mm.

From opening of fourth ventricle to prominence of first spinal nerve, and between the several cervical nerves, each, 5 mm.

Height of medulla at sixth nerve, 5.5 mm.

Height of medulla and cerebellum, 10 mm.

GENERAL RESULTS.

1. The existence of very distinct types of cell-structure in the cerebrum; these being related to the sensory and motor tracts respectively.

2. A diversity in axial direction between the motor and sensory cells, and the probability that the connection between them is from the acute end of the one to the blunt end of the other.

3. The existence of a well-developed callosum and anterior commissure, as well as a less distinct fornix commissure in the alligator.

4. The anterior commissure a true commissure of the axial lobes.

5. The direct course of the tænia thalami, from the ventro-posterior region of the hemispheres to the region of the superior commissure.

6. The absence of direct fibres from the optic tracts to the cerebrum.

7. The well-developed superior commissure.

8. The structure of colliculi and corpus posterius and their connection.

9. The structure of the tuber cinereum.

10. The different axial position of sensory and motor cells in the medulla.

11. The connection between the several nuclei of motor nerves of the eye-ball with the optic lobes and structure of the latter.

12. Peripheral course of the cerebral nerves.

13. The relation between the roots of the twelfth and eleventh nerves.

EXPLANATION OF PLATES.

Plate VII.

Figs. 1–3.—Superficial views of the brain of a young alligator, as seen from the side, from below, and from above. The numerals indicate the pairs of cranial nerves.

Fig. 4.—Diagram of the ventral distribution of the cranial nerves.

Fig. 5.—Diagram of the cranial nerves, as seen when the skull and atlas are partially removed from the lateral aspects of the head.

Fig. 5*a*.—Enlarged view of the vagus and glossopharyngeal ganglia, with the nerves connected. The point of entrance of the hypoglossal is indicated at XII., but it is really hidden behind the ganglion.

Fig. 6.—Cells of the olfactory type, from hippocampal region.

Figs. 7, 8.—Cells from the axial lobe, from a section slightly dorsal to Fig. 4, Plate XI., in the middle of the posterior protuberance. Cells rapidly multiplying by division.

Fig. 9.—Portion of cortex showing relation between the motor (*b*) and sensory (*a*) cells. The arrow indicates the direction of the surface.

Fig. 10.—Cells from the extreme antero-median region, as seen in section figured Plate XI., Fig. 4. Combination of motor and sensory cells. The periphery is here above, the ventricle below. Three flask-cells are seen in the lower left corner.

Fig. 11.—Portion of section figured on Plate X., Fig. 2, at *a*; *i. e.*, from the occipital region.

Fig. 12.—A typical sensory area of the cortex from slide 10.

Plate VIII.

A series of nineteen transverse sections through the cerebrum and other parts as far backward as to the cerebellum.

c. c., corpus callosum; *a. c.*, anterior commissure; *ol. t.*, olfactory tracts (?) to the fornix region; *ol. t'.*, lateral olfactory tracts; *p.*, longitudinal fibres of crura; *t. th.*, tænia thalami; *o. tr.*, optic tracts; *t.*, tract passing from inferior lateral margin of the ventricle to the tænia (?); *tr. t.*, tracts crossing to the peduncle transversely from lateral region of hemisphere; *c. gn.*, corpus geniculatum; *m. c.*, middle commissure; *s. c.*, superior commissure; *col.*, colliculi of optic lobes; *tec. o.*, tectum opticum; *x.*, fibræ ansulatæ (? ?).

Plate IX.

Chiefly longitudinal vertical sections through the brain.

Fig. 1.—Section from the extreme side of the medulla.

Fig. 2.—Section in a nearly corresponding plane through the optic lobes and hemispheres.

Fig. 3.—Section nearer the median plane, showing the position of the roots of the fifth, eighth, tenth and twelfth nerves.

Fig. 4.—Corresponding section of anterior portion of the brain. *c. p.*, corpus posterius; *p. f.*, peduncular tracts, where they diverge; *f. a.*, fibræ ansulatæ (?).

Figs. 5, 6.—Sections still nearer median plane. *c. post.*, posterior commissure; *col.*, colliculi; *c. p.*, corpus posterius; *o. tr.*, optic tracts; *o.*, olfactory tracts.

Figs. 7, 8.—Sections quite near the median line. *c. s.*, superior commissure; *t. th.*, tænia thalami; *a. c.*, anterior commissure; *c. gn.*, corpus geniculatum; *M. b.*, Meynert's bundle; *tr. p. c.*, tract from region of posterior commissure; *g. ip.*, interpeduncular ganglion; *IV.*, *r.*, roots of fourth nerve; just in front of it the tracts to cerebellum appear.

Fig. 9.—A section through the front part of the brain, a little lateral to that of Fig. 8. *t.*, tract from colliculi to corpus posterius; *III.*, *r.*, roots of third nerve; *o. n.*, optic nerve.

Fig. 10.—From the motor nucleus of the fifth nerve.

Fig. 11.—A motor area of the cortex from the section of Fig. 5, Plate VIII., which see. The surface is to the right, the epithelium of the ventricle to the left.

Plate X.

Chiefly horizontal sections through the thalamus and the hemispheres.

Fig. 1.—Section below (ventrad to) the anterior commissure.

Fig. 2.—Section from a somewhat higher level.

Figs. 3–6.—Sections successively ventrad to Fig. 1, Fig. 6 being through the tuber cinereum and chiasm. *f. a.*, fibræ ansulatæ (?); *tr. o.*, optic tracts; *ol. t.*, olfactory tracts; *c. i.*, *c. e.*, for the most part fibres from the inferior commissure; *ch.*, chiasm.

Fig. 7.—Portion of the nucleus of the tenth nerve. The tract at the left passes to the root of the vagus. The two kinds of cells mentioned in the text are here shown, the sensory variety predominating.

Plate XI.

Sections in various planes through the brain.

Fig. 1.—Posterior portion of a horizontal section through the hemispheres and optic lobes, below the level of the superior commissure. *Ac.*, ascending fibres from the region of the anterior commissure; *t. th.*, tænia thalami; *p. c.*, posterior commissure; *a.*, fibres to corpus posterius; *b.*, posterior optic tracts.

Fig. 2.—Section near the posterior margin of the optic lobes.

Fig. 3.—Section at the exit of fourth nerve.

Fig. 4.—Horizontal section at the level of the corpus callosum. *c. c.*, corpus callosum; *o. t.*, olfactory tracts; *f.*, fornix; *p. t.*, peduncular tracts; *a. c.*, anterior commissure fibres. The index line points to a locus where there are apparently other fibres entering the thalamus from the hemisphere; *c. gn.*, corpus geniculatum; *o. tr.*, optic tracts.

Fig. 5.—Section through medulla and cerebellum at the crura cerebelli. *V. n.*, motor nucleus of the fifth nerve; *b.*, locus of transverse multipolar cells (Fig. 12, Plate VII.).

Plate XII.

Sections through the optic lobes and thalamus.

Fig. 1.—Section through the hemispheres and thalamus anterior to the middle commissure. *t. th.*, tænia thalami; *f. a.*, fibræ ansulatæ (?); *o. tr.*, optic tracts.

Fig. 2.—Section behind the superior commissure and through the optic lobes. *a.* and *b.*, portions of the tectum drawn upon an enlarged scale in Figs. 7 and 8; *col.*, colliculi.

Fig. 3.—Transverse section through the optic lobes at the level of the third nerves. *tec.*, tectum opticum; *col.*, colliculi; *d. t.*, descending decussating tract from the optic lobes; *n. III.*, nucleus of oculomotor nerve.

Fig. 4.—Section through thalamus at the median commissure.

Fig. 5.—Section through thalamus at the posterior commissure. *c. gn.*, corpus geniculatum; *f. a.*, fibræ ansulatæ; (?) *p. c.*, posterior commissure.

Fig. 6.—Cells from the basi-lateral part of the axial lobe of the cerebrum. See Plate X., Fig. 1.

Fig. 7.—Central portion of section figured at Fig. 2 of this plate, showing giant cells and fibres.

Fig. 8.—Lateral portion of same section in tectum opticum, with a single sporadic giant cell.

Plate XIII.

A series of sections through the medulla and details.

Fig. 1.—Section at the origin of the eighth nerve, its nucleus at *a*.

Fig. 2.—Section near the exit of the ninth nerve.

Fig. 3.—Section of the root of the ninth and tenth. Compare Fig. 7, Plate X., for structure of nucleus.

Fig. 4.—Section at the exit of the twelfth. *c. c.*, canalis centralis; *n. XII.*, nucleus of twelfth nerve (see Fig. 10 for details); *n. XI.*, nucleus of the spinal accessory, which emerges from the lateral groove near the letter *a*.

Fig. 5.—A section somewhat further back with same structure.

Fig. 6.—A similar section near the anterior roots of the cord.

Fig. 7.—Nucleus of the hypoglossal nerve.

Fig. 8.—Portion of Fig. 2 enlarged.

Fig. 9.—Portion of section through nuclei of the third nerve.

Fig. 10.—Nucleus of hypoglossal nerve.

Plate XIV.

A series of horizontal sections of the medulla.

Fig. 1.—Section at the level of the lower fibres of the fifth nerve. *a*, *b*, *c*, external, intermediate and medio-basal longitudinal bundles; *x*, fibres of the girdle bundles; *o.*, olive; *n. v. s.*, supposed sensory nucleus of the fifth nerve; *n. v. m.*, motor nucleus of same; *n. p.*, corpus posterius.

Fig. 2.—Similar section at a higher level.

Figs. 3, 4, 5.—Similar sections at successively higher levels. *n. VIII. a*, chief nucleus of the auditory nerve; *VIII. b*, second nucleus of the auditory; cf., Figs. 6, 7.

Figs. 6, 7.—Cells of the auditory nucleus cut transversely (Fig. 6) and longitudinally (Fig 7).

Fig. 8.—Portion of a horizontal section through the region of the infundibulum, in tuber cinereum.

Fig. 9.—A portion of the optic nerves near the chiasm cut longitudinally.

Plate XV.

Fig. 1.—Ganglion of raphe as seen in a section through the peduncles of the cerebellum, a little posterior to the section figured on Plate V., Fig. 5. ½ in. obj. camera. Cf., Fig. 10, which shows three cells from same region as Fig. 5, *b*, Plate XI., and also drawn with ½ in. obj.

Fig. 2.—Portion of nucleus of auditory nerve (Cf., Fig. 1, *a*, Plate XIII. Cf. also, Fig. 3, Plate IX.). *n. VIII.* corresponds with that represented at *a*. *n. VIII.* is a more lateral portion interstratified between fibre bands, and corresponds to *b* in the present figure. The apical processes of the flask-cells *a* are continued into fibres to the raphe.

Fig. 3.—Cells from the section figured Plate XIII., Fig. 2, *b*. (Cf., Fig. 8, Plate XIII.) Large switch-cells of anterior zone in a section in about the region of the ninth nerve.

Figs. 3, 4.—Longitudinal vertical sections through the prosencephalon and diencephalon, Fig. 4 being farther from the median line. On the same scale and for comparison with Figs. 4, 6, 8 and 9 of Plate IX., but from another specimen. *p. f.*, pyramidal fascicle; *p. f.*, upper longitudinal fascicle; *o. tr*, optic tracts; *c. g.*, corpus geniculatum; *t. t.*, tænia thalami; *a. c.*, anterior commissure tract.

Fig. 6.—Longitudinal section of olfactory bulb.

Fig. 6 *a*.—The ganglion layer enlarged at the point *a* of the preceding figure.

Fig. 7.—Section through the thalamus in front of the middle commissure, at the point where the tænia thalami cross from the infero-basal region of the hemisphere to the sides of the thalamus. *ch.*, optic chiasm; *p. f.*, peduncular fascicle; *t. th.*, tænia thalami; *c. g.*, corpus geniculatum.

Fig. 8.—Portion of a horizontal section behind the colliculi, at a point where the fibres of the optic lobes are collected to enter the corpus posterius. Large cells, of the same type as those of the anterior zones of the cord, as seen with $\frac{1}{5}$ in. obj.

Fig. 9.—Cells from the colliculi of the optic lobes, as seen in horizontal section with $\frac{1}{5}$ in. obj.

Fig. 10.—See under Fig. 1.

Fig. 11.—Cells from the motor root of the fifth nerve. (Cf., Plate XI., Fig. 5, Vn.) Camera drawings with $\frac{1}{2}$ in. obj.

NORTH AMERICAN FUNGI.

By A. P. Morgan.

Third Paper.

(Continued from Vol. XII., p. 22.)

(Read by title Feb. 4, 1890.)

THE GASTROMYCETES.

Order II.—Lycoperdaceæ. (Continued.)

II. Corticatæ. Outer peridium (cortex) at first a soft fragile layer, often with external projections in the shape of warts, spines or scales, adhering firmly to the inner peridium; after deliquescence drying up, and to a greater or less extent peeling off and falling away; inner peridium membranaceous or subcoriaceous, variously dehiscent. Columella none; in place of it the basal portion of the gleba (*subgleba*) often sterile and persistent.

Genus VII.—Tylostoma, Pers.

Mycelium slender, fibrous, often much branched and interwoven, and with the inclosed soil forming a bulb-like mass at the base of the stipe. Peridium depressed-globose, at first with a thickened base, which at maturity elongates into a distinct stipe; the stipe lacerate-scaly, white within and fibrillose-stuffed, the apex entering a deep depression in the base of the peridium, which encircles it like a collar; cortex consisting of scales or warts, usually deciduous, sometimes persistent; inner peridium membranaceous or subcoriaceous, dehiscent by an apical mouth. Capillitium originating from the inner surface of the peridium; the threads very long, hyaline, much branched and interwoven; spores small, subglobose, sessile, pale brown. See Plate XVI., A.

Plants growing on the ground oftenest in dry and sandy regions. The genus is readily distinguished from all others of the Lycoperdaceæ by the entire peridium being mounted upon the apex of the stipe. The threads of the capillitium are scarcely different from the closely woven hyphæ which form the inner peridium; in its internal structure the genus is related to Astræus and to Catastoma.

§ 1. Cyclostoma. *Mouth small, circular, prominent, entire.*

1. T. mammosum, Mich. Peridium depressed-globose, the cortex of minute brown scales soon seceding; inner peridium thin,

membranaceous, smooth, whitish; the mouth small, circular, prominent, entire. Stipe short, slender, lacerate-scaly, becoming smooth, with a central pith of long loose threads, finally hollow; the mycelial bulb small. Threads of the capillitium long, slender, about as thick as the spores, hyaline, branched; spores globose, minutely warted, pale brown, 4.5—5.5 mic. in diameter.

Growing in rich sandy soil. New York, *Underwood;* North Carolina, *Curtis;* New Mexico, *Wright*, *Fendler;* Kansas, *Kellerman;* Nebraska, *Webber;* Colorado, *Ellis*. Plant 1–2 inches in height, the peridium ¼–½ of an inch in diameter, the stipe about ¼ of an inch in thickness. *T. brumale*, D C. and *T. squamosum*, Pers., are said to be synonyms of this species.

2. T. VERRUCOSUM, Morg. n. sp. Peridium depressed-globose, thickish, becoming firm and rigid, with a dense brown cortex of minute persistent scales and warts; the mouth small, circular, prominent, entire. Stipe long, slender, with a surface of brown lacerate scales, internally white, with a central pith of long loose fibers; the mycelial bulb large, irregularly depressed-globose. Threads of the capillitium long, slender, about as thick as the spores, hyaline, branched; spores irregularly globose, minutely warted, pale brown, 5–6 mic. in diameter.

Growing on the ground in rich soil in woods. Ohio, *Morgan*. Plant 2–4 inches in height, the peridium about ½ of an inch in diameter, the stipe nearly ¼ of an inch thick; the mycelial bulb is sometimes larger than the peridium. It seems altogether different from *T. exasperatum*, Mont.

§ 2. SCHIZOSTOMA. *Mouth irregular, lacerate.*

3. T. FIMBRIATUM, Fr. Peridium depressed-globose, the cortex of minute scales soon falling away, and leaving a smooth brownish surface to the thin membranaceous inner peridium; the mouth plane, ciliate-fimbriate. Stipe short, rather thick, the surface brown and scaly-lacerate, white within and fibrillose-stuffed, with a small mycelial bulb at the base. Threads of the capillitium long, slender, about as thick as the spores, hyaline, branched; spores subglobose, pale brown, minutely warted, 5–6 mic. in diameter.

Growing in sandy soil. New York, *Peck;* North Carolina, *Curtis;* Texas, *Wright;* New Mexico, *Wright;* Kansas, *Kellerman*. Plant 1–2 inches in height, the peridium nearly ½ of an inch in diameter, the stipe scarcely ¼ of an inch in thickness.

4. T. CAMPESTRE, Morg. n. sp. Peridium depressed-globose, the brown scaly cortex gradually falling away; inner peridium thickish, submembranaceous, becoming smooth and whitish; mouth plane, irregular, lacerate, not fimbriate. Stipe long, thick, nearly equal, with broad brown scales, white within and fibrillose-stuffed, with a small, irregular, mycelial bulb at the base. Threads of the capillitium long, slender, about as thick as the spores, hyaline, branched; spores irregularly globose, pale brown, very minutely warted, 4.5–5.5 mic. in diameter.

Growing in sandy soil. Nebraska, *Webber;* California, *Underwood.* Plant 1–3 inches in height, the peridium ½–¾ of an inch in diameter, the stipe about ¼ of an inch in thickness. This species has hitherto been referred to *T. Berteroanum*, Lev., but it appears to differ from it essentially in the character of the mouth; this is only a torn aperture, sometimes a mere slit, not at all elevated, nor ciliate-fringed. It is a much larger plant than *T. fimbriatum.*

5. T. MEYENIANUM, Kl. Peridium depressed-globose; the cortex soon seceding, leaving a smooth whitish or yellowish surface to the submembranaceous inner peridium, the apex plane with a lacerate mouth. Stipe long, thick, unequal, fusiform or tapering, nearly solid, sulcate. Threads of the capillitium long, much thicker than the spores, branched, hyaline; spores subglobose, even, pale brown, 4.5–5.5 mic. in diameter.

Growing in sandy soil. New Mexico, *Wright:* Colorado, *Webber.* Plant 2–4 inches in height, the peridium ¾–1 inch in diameter, the stipe about ½ of an inch in thickness at the thickest part. Specimens referred to *T. angolense*, W. & C., do not differ otherwise than in having the stipe thickest at the apex and tapering downward instead of fusiform. *T. obesum*, C. & E., appears to be founded on a specimen with the short thick stipe not fully developed.

Genus VIII.—CALVATIA, Fr.

Mycelium fibrous, usually thick and cord-like, rooting from the base. Peridium large, globose and nearly sessile, or turbinate with a well-developed base; cortex a very thin adherent layer, often smooth and continuous, sometimes composed of minute spinules or granules; inner peridium a loosely woven and very fragile covering, after maturity breaking up into fragments from above downward and gradually falling away. Subgleba cellulose, mostly

definitely limited and concave above, persistent; mass of spores and capillitium dense, compact, persistent a long time and slowly dissipating after the fracture of the peridium; the threads very long, slender, much branched and interwoven; spores small, globose, usually sessile or with only a minute pedicel. See Plate XVI., B.

Puffballs of the largest size, growing on the ground in fields and woods. The species of this genus separate quite naturally into three distinct sections, all agreeing, however, in the irregular fracture of the upper part of the peridium and the dense persistent nature of the capillitium. The inner peridium in the typical species is a sort of felted structure of coarse hyphæ often with broad expansions; they are of larger diameter than the capillitium threads, but their walls are thin and fragile. The extremely long and slender threads of the capillitium, proceeding from the inner surface of the peridium, traverse the tissues of the gleba, branching continually in all directions and becoming thoroughly entangled and interwoven, until it is impossible to separate any single thread from the others.

This genus was established by Fries in the "Summa Veget. Scand.," p. 442, to include the *Bovista craniiformis* of Schweinitz; if allowed to stand it must necessarily include *Lycoperdon cyathiforme*, Bosc, which has precisely the same structure of the cortex and inner peridium; and this carries with it two or three closely related species. A clearer view of the numerous smaller puffballs, the Lycoperdons proper, can evidently be taken by limiting them to a membranaceous peridium dehiscent by an apical mouth; hence our extension of the genus Calvatia to include the globose *Lycoperdon maximum*, Schæff, and the stipitate *Lycoperdon saccatum*, Vahl.

§ 1. Sessiles. Peridium very large, without a distinct base; subgleba nearly obsolete, the mass of spores and capillitium quite filling the interior.

1. C. maxima, Schæff. Peridium very large, globose depressed-globose or obovoid, with a thick cord-like root. Cortex a flocculose or nearly smooth continuous layer, very thin and fragile, white or grayish, changing to yellowish, drying up and becoming brown, remaining closely adherent to the inner peridium or sometimes peeling off in patches: inner peridium thin and very fragile, after maturity gradually breaking up into fragments and falling

away. Subgleba very shallow or quite obsolete; mass of spores and capillitium greenish-yellow, then brownish olivaceous; the threads very long, frequently septate, branched, the primary branches much thicker than the spores, the ultimate ones more slender; spores globose, even or sometimes very minutely warted, 3.5–4.5 mic. in diameter, often with a minute pedicel.

Growing on the ground in grassy places in fields and woods. New England, *Sprague;* New York, *Peck;* Pennsylvania, *Schweinitz;* N. Carolina, *Curtis;* Ohio, *Davis L. James;* Wisconsin, *Trelease;* Kansas, *Cragin;* California, *Harkness.* Peridium commonly 6–12 inches in diameter, but much larger specimens are sometimes met with. August Foerste records one that a farmer near Centreville, O., brought him, which measured 20 inches in diameter with a height of 15 inches and weighed 17¾ lbs. Schweinitz affirms that he found specimens of this puffball 3 feet in diameter. This species is said to be the *Lycoperdon bovista*, Linn. It is *L. maximum*, Schæff., and *L. giganteum*, Batsch. Mycophagists pronounce this puffball excellent eating. Badham says the best method by which to cook it is to cut it into slices and to fry these in egg and bread crumbs; so prepared, it has the flavor of a rich light omelette. The specimens selected for eating must be white inside and perfectly fresh.

2. C. PACHYDERMA, Peck. Peridium very large, globose or obovoid, often irregular, with a thick cord-like root. Cortex thin, smooth, whitish, persistent, drying up into polygonal areolæ which are white in the center with a brown border; inner peridium very thick but fragile, with a separable membranaceous lining, after maturity gradually breaking up into fragments and falling away. Subgleba obsolete; mass of spores and capillitium greenish-yellow then olive-brown; the threads very long, occasionally septate, branched, mostly thinner than the spores; spores globose, distinctly warted, 5–6 mic. in diameter, sometimes with a minute pedicel.

Growing on the ground. Arizona, *Pringle;* Dakota, *Miss Nellie Crouch.* Peridium 4–8 inches in diameter. Remarkable for its thick peridium, which becomes white spotted and areolate. This species is *Lycoperdon pachydermum*, Peck, "Bot. Gazette," Vol. VII., p. 54. *L. lepidophorum*, E. & E., "Journal of Mycology," Vol. I., p. 88, seems to me to be only the younger state of this species. Mr. Ellis, however, considers the inner membranaceous

lining of the peridium to be the true inner peridium, and the thick subcortical structure the cortex. This same peculiar membrane appears to exist in *C. sigillata.*

§ 2. CYATHIFORMES. Peridium large, obovoid or turbinate, with a stout thick base; subgleba definitely limited and concave above, persistent.

a. Mass of spores and capillitium violet or purple.

3. C. CYATHIFORMIS, Bosc. Peridium large, broadly obovoid or turbinate, depressed above, the base usually thick and stout, with a cord-like root. Cortex a smooth continuous layer, very thin and fragile, easily peeling off, whitish gray or brown, taking on a violet or purplish tinge, the upper part often becoming areolate; inner peridium thin, pale to dark purple, velvety, extremely fragile, after maturity the upper part soon breaking up into fragments and falling away. Subgleba occupying from a third part to one-half of the peridium, cup-shaped above, a long time persistent; mass of spores and capillitium at first violet, then pale to dark purple; the threads very long, thinner than the spores, scarcely branched; spores globose distinctly warted or echinulate, 5–7 mic. in diameter, sessile.

Growing on the ground in meadows and pastures. New England, *Frost;* New York, *Peck;* Pennsylvania, *Gentry;* N. Carolina, *Curtis;* S. Carolina, *Bosc, Ravenel;* Mississippi, *Tracy;* Ohio, *Morgan.* Peridium commonly 3–5 inches in diameter, though sometimes found both larger and smaller than these dimensions. This is the most common and abundant large puffball in the eastern United States. The original name is *Lycoperdon cyathiforme,* Bosc, in Berl. Mag., V., p. 87, Fries S. M. Vol. III., p. 60. Bosc's figure and description were of the empty cup-shaped base; but he having indicated the color, there can be no doubt of the proper application of the name. *Bovista lilacina,* B. & M., is undoubtedly this same species. Possibly this is the *Lycoperdon areolatum* of Schweinitz's N. A. Fungi. Small forms of this species with a short and pointed base are scarcely to be distinguished from the following species otherwise than by the larger and more distinctly warted spores. This is said to be an edible species.

4. C. FRAGILIS, Vitt. Peridium obovoid, plicate below, with a short pointed base and a cord-like root. Cortex a smooth continuous layer, very thin and fragile, separable, white or grayish

becoming brownish and tinged with violet and purple, commonly areolate above; inner peridium thin, violet to purple, velvety, extremely fragile, after maturity the upper part soon breaking up into fragments and falling away. Subgleba occupying but a small portion of the peridium, cup-shaped above, persistent; mass of spores and capillitium from violet to pale purple; the threads very long, mostly thinner than the spores, scarcely branched; spores globose, minutely warted, 4–5.5 mic. in diameter, sessile.

Growing on the open prairies. Wisconsin, *Brown;* Iowa, *McBride;* Nebraska, Wyoming, *Webber;* Kansas, *Cragin;* California, *Harkness*. Peridium 1½–3 inches in diameter. While evidently closely related to *C. cyathiformis*, this is plainly a different species; it is smaller in size, and the spores and capillitium are paler in color, being more persistently violet; the spores are smaller and very minutely warted. It is no doubt the *Lycoperdon radicatum*, W. & C., of the Pacific Coast Catalogue, this name being most likely a synonym of *L. fragile*, Vitt. *Bovista cinerea*, Ellis, in Bulletin of Washburn College, is founded on specimens of this species.

5. C. SIGILLATA, Cragin. Peridium large, depressed above, narrowed below into a stem-like base. Cortex very thin and fragile, white, easily abraided; inner peridium subcoriaceous, with a fragile ferruginous brown lining, marked off above into polygonal areas by lines of depression, at length breaking up into fragments and falling away. Mass of spores and capillitium violet to dark purple; spores globose, even, 3.5–4.5 mic. in diameter, with a long pedicel.

Growing on the open prairie. Kansas, *Cragin*. Peridium 4–5 inches in diameter. The species is well marked by the even pedicellate spores.

b. Mass of spores and capillitium olivaceous.

6. C. CÆLATA, Bull. Peridium large, obovoid or turbinate, depressed above, with a stout thick base and a cord-like root. Cortex a thickish floccose layer, with coarse warts or spines above, whitish then ochraceous or finally brown, at length breaking up into areolæ which are more or less persistent; inner peridium thick but fragile, thinner about the apex, where it finally ruptures, forming a large irregular lacerate aperture. Subgleba occupying nearly half the peridium, cup-shaped above and a long time persistent; mass of spores and capillitium compact, farinaceous, greenish-yellow

or olivaceous, becoming pale to dark brown; the threads very long, much branched, the primary branches two or three times as thick as the spores, very brittle, soon breaking up into fragments; spores globose, even, 4–4.5 mic. in diameter, sessile or sometimes with a short or minute pedicel.

Growing on the ground in fields and woods. Wisconsin, *Brown;* Minnesota, *Johnson;* Kansas, *Kellerman.* Peridium 3–5 inches in diameter, sometimes larger. This is *Lycoperdon cœlatum*, Bull., of Saccardo's Sylloge and of Massee's monograph; it is *L. Bovista*, Pers. The specimens referred by Trelease to *L. favosum*, Rostk., probably belong to this species.

7. C. HIEMALIS, Bull. Peridium obovoid or turbinate, depressed above, with a stout thick base and a cord-like root. Cortex a thin furfuraceous coat, with stout convergent spines above, whitish or gray, becoming yellowish and rufescent, after maturity gradually falling away from the upper part; inner peridium thin, submembranaceous, pallid or brownish, dehiscent at the apex by an irregular lacerate mouth. Subgleba occupying nearly half the peridium, cup-shaped above and a long time persistent; mass of spores and capillitium soft, lax, greenish-yellow then brownish-olivaceous; the threads very long, much branched, the primary branches about as thick as the spores, the ultimate ones long, slender and tapering; spores globose, even, 3.5–4.5 mic. in diameter, with a short or minute pedicel.

Growing on the ground in fields and pastures. Peridium 2–4 inches in diameter and 3–5 inches in height. I find this species referred to N. America in Saccardo's Sylloge. It is *Lycoperdon cœlatum* of Fries S. M. Possibly the *L. cœlatum* of Curtis's Catalogue may be this species.

8. C. CRANIIFORMIS, Schw. Peridium very large, obovoid or turbinate, depressed above, the base thick and stout, with a cord-like root. Cortex a smooth continuous layer, very thin and fragile, easily peeling off, pallid or grayish, sometimes with a reddish tinge, often becoming plicate-areolate; inner peridium thin, ochraceous to bright brown, velvety, extremely fragile, after maturity the upper part breaking up into fragments and falling away. Subgleba occupying about one-half of the peridium, cup-shaped above and a long time persistent; mass of spores and capillitium greenish-yellow then ochraceous or dirty olivaceous; the threads very long, about as thick as the spores, branched; spores globose, even, 3–3.5 mic. in diameter, with a minute pedicel.

Growing on the ground in woods. Pennsylvania, *Schweinitz, Ellis;* Maryland, *James;* S. Carolina, *Atkinson;* Mississippi, *Tracy;* Ohio, *Morgan;* Missouri, *Trelease;* Iowa, *McBride.* Peridium commonly 3–6 inches in diameter and 4–5 inches in height, but much larger specimens are sometimes met with. This species abounds in the woods of Southern Ohio, growing in great patches of numerous individuals. It was first described by Schweinitz under the name *Bovista craniiformis,* N. A. Fungi No. 2256. *Lycoperdon delicatum,* B. & C.=*L. Berkeleyi,* Massee, and *L. Missouriense,* Trelease, are more recent names for this species. I am indebted to Mr. J. B. Ellis for specimens from Pennsylvania and for the identification of them with the original specimens in the herbarium of Schweinitz. I do not know that the edible qualities of this species have been tested.

9. C. RUBRO-FLAVA, Cragin. Peridium obconic, tapering gradually downward to the rooting mycelium. Cortex a very thin furfuraceous or granulose coat, with a few short, scattered spinules above; inner peridium thin and fragile, at first whitish, soon becoming orange-red to orange-brown in color, after maturity the upper part breaking up into fragments and falling away. Subgleba occupying about a third part of the peridium; mass of spores and capillitium reddish-ochre then olivaceous-orange; the threads very long, rather thicker than the spores, branched; spores globose, even, 3–3.5 mic. in diameter, sometimes with a minute pedicel.

Growing on the ground. Kansas, *Cragin, Kellerman.* Peridium 1½–3 inches in height with a breadth of 1–2 inches. The peculiar orange or rather reddish-ochre color with which the whole plant is pervaded at maturity is very remarkable.

§ 3. STIPITATÆ. Peridium depressed-globose above, abruptly contracted below into a long stem-like base; subgleba not definitely limited above, continuous with the capillitium, persistent.

10. C. SACCATA, Vahl. Peridium depressed-globose above, plicate below and abruptly contracted into a long stem-like base; the base thick and stout, often lacunose, nearly equal, rarely tapering downward; mycelium fibrous and filamentous. Cortex a very thin coat of minute persistent spinules or granules; inner peridium white or gray becoming brownish, very thin and fragile, after maturity the upper part soon breaking up into fragments and falling away. Subgleba occupying the stem-like base, persistent; mass of spores and capillitium brownish-olivaceous; the threads

very long, branched, the main stem thinner than the spores, the branches slender; spores globose, distinctly warted or echinulate, 5–6 mic. in diameter.

Growing in thickets and open woods among mosses. Peridium 1–2 inches in diameter and 3–5 inches in height, the stem-like base 1 inch or more in thickness. This species has been reported from N. America by various authorities, but I have never seen any American specimen.

11. C. ELATA, Massee. Peridium globose or depressed-globose above, plicate below and abruptly contracted into a long stem-like base; the base slender, cylindric or tapering downwards, sometimes lacunose; mycelium fibrous and filamentous. Cortex a very thin coat of minute persistent spinules or granules; inner peridium white or cream-colored becoming brown or olivaceous, very thin and fragile, after maturity the upper part soon breaking up into fragments and falling away. Subgleba occupying the stem-like base, a long time persistent; mass of spores and capillitium brown or brownish-olivaceous; the threads very long, branched, the main stem as thick as the spores, the branches more slender; spores globose, even or very minutely warted, 4–5 mic. in diameter with a short or minute pedicel.

Growing among mosses in low grounds and bushy places. New England, *Humphrey*; New York, *Peck*. Peridium 1–2 inches in diameter and 3–6 inches in height, the stem-like base ½–¾ of an inch in thickness. This American form of *Lycoperdon saccatum* has lately been separated from it, and named, figured and described as *Lycoperdon elatum*, by George Massee.

EXPLANATION OF PLATE XVI.

A. TYLOSTOMA, Pers.

1. T. mammosum, Mich.
2. T. verrucosum, Morg.
3. T. fimbriatum, Fr.
4. T. campestre, Morg.
5. T. Meyenianum, Kl.

B. CALVATIA, Fr.

6. C. craniiformis, Schw.
7. C. elata, Massee.

NEW LOWER SILURIAN BRYOZOA.

BY E. O. ULRICH.

(Read by title January 7, 1890.)

THE Bryozoa described in this paper are mainly from the Trenton Shales of Minnesota, where they were collected during the month of October, 1887. All the specimens are in the author's cabinet.

VINELLA, n. gen.

This genus is proposed for an adnate form supposed to be a Ctenostomatous bryozoan, with relations to *Vesicularia*, Thompson, and probably also to *Mimosella*, Hincks.

Zoarium attached to foreign bodies (shells, etc.), consisting of exceedingly slender, ramifying, thread-like tubes, occasionally arranged in a radial manner. Surface of tubes often faintly lined longitudinally. A row of widely separated small pores along the center of the surface of the tubes. Zoœcia unknown. Type, *Vinella repens*, n. sp.

As interpreted by me, the fossils for whose reception this genus is proposed represent the stoloniferous part of the bryozoan only. The zoœcia I regard as having been deciduous, and developed by budding from the creeping stolons at the points now represented by the small pores.

Named in honor of Mr. G. R. Vine, of England, who was the first to suggest the relation of *Rhopalonaria* and *Ascodictyon* to the Ctenostomatous Bryozoa.

VINELLA REPENS, n. sp.

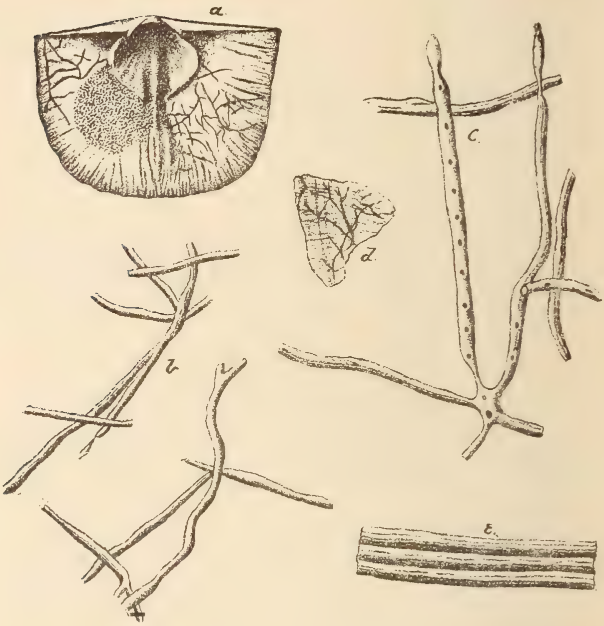

FIG. 1.—*Vinella repens*, n. gen. et sp. *a*, two colonies attached to the inner side of the ventral valve of a thin variety of *Streptorhychus filitextus*, Hall. *b*, part of one of them magnified eighteen times. The pores are absent, probably not having been preserved. *c*, Part of another portion of same, x18, showing a central point with five divisions of the tubular stolon radiating from it. This portion of the specimen also preserves the pores, marking the points where the zoœcia were attached. *d*, another specimen attached to fragment of shell. *e*, small portion of same where three tubes lie parallel with each other. No pores could be made out on this specimen, but the longitudinal lines are more distinct than on the other specimen.

Zoarium repent, the stolons delicate, thread-like, often longitudinally striate, straight or flexuous; from 0.06 to 0.11 mm. in diameter; bifurcating often and sometimes arranged in a radical manner about a central node. Where best preserved, very small pores arranged uniserially along the center of the upper surface of the threads; about eleven in 2.5 mm. Zoœcia unknown, probably deciduous.

Similar organisms occur in Cincinnati, Wenlock and Chester groups. Being undescribed, comparisons would be useless.

Position and locality: Upper beds of the Trenton Shales at St. Paul, Minn.

STOMATOPORA TENUISSIMA, n. sp.

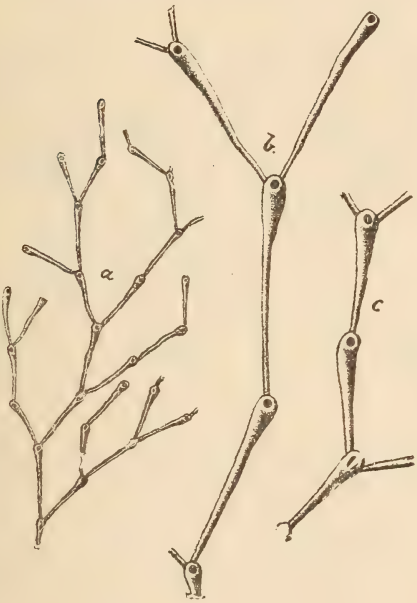

FIG. 2.—*Stomatopera tenuissima*, n. sp. and *S. proutana*, Miller. *a*, portion of zoarium of *S. tenuissima*, x7, showing its slender zoœcia and mode of growth; *b*, several zoœcia of same magnified eighteen diameters, to show their apertures and form more clearly. *c*, several zoœcia of one of the most slender examples of *S. proutana* seen. Introduced for comparision.

Zoarium adnate, consisting of frequently branching uniserially arranged zoœcia. Zoœcia exceedingly slender, about seven in eight mms., each from 1.0 to 1.5 mm. long, usually increasing very gradually from the proximal end, where the diameter is about 0.04 mm., to near the slightly bulbous anterior or upper end, which varies from 0.11 to 0.18 mm. in diameter. Aperture circular, small, about 0.05 mm. in diameter, situated very near the anterior end of the zoœcium.

This and *S. turgida* illustrate the extremes of difference in shape and size of the zoœcia of *Stomatopora* so far noticed. *S. tenuissima* is closely related to *S. proutana*, Miller, but its zoœcia are much longer. Miller's species, with scarcely any modification, ranges from low in the Trenton (Birdseye limestone) to the top of the Cincinnati group.

Position and locality: Toward the top of the Utica horizon of

the Cincinnati group at Cincinnati, Ohio, 150 to 175 ft. above low water mark in the Ohio River.

STOMATOPORA TURGIDA, n. sp.

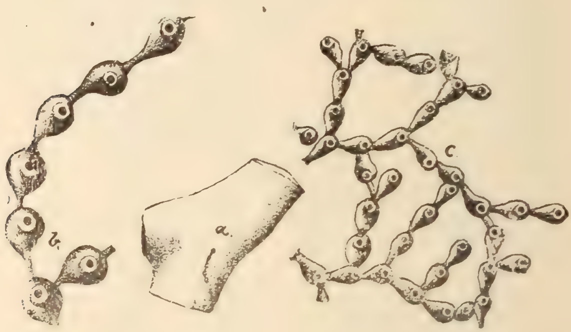

FIG. 3.—*Stomatopora turgida*, n. sp., and *S. inflata*, Hall. *a*, zoarium of *S. turgida*, growing upon *Pachydictya splendens*, Ulr., natural size. *b*, same enlarged to seven diameters, showing the swollen zoœcia and small apertures. *c*, small portion of the zoarium of the turgid Cincinnati variety of *S. inflata*, Hall, also magnified seven diameters. Introduced for comparison with *S. turgida*.

Zoarium adnate, consisting of a single branching series of zoœcia. Zoœcia comparatively very large, the anterior half much swollen, rapidly tapering posteriorly with the slender, tubular proximal end inserted beneath the turgid anterior end of the preceding zoœcium. Five zoœcia, in five mm.; length of each zoœcium varying from 0.85 to 1.30 mm.; the greatest diameter of the anterior half from 0.4 to 0.6 mm. The longest cells are the least turgid, while the shortest are the most. Apertures round, bordered by an elevated margin, small, 0.1 mm. in diameter, and situated about one-fourth of the length of a zoœcium from its anterior end.

I have a number of specimens of this species, and all consist of comparatively few zoœcia. Nor do the series of cells in any of them branch often, from which it appears that the production of two "gems" was a much less frequent occurrence than in the related *S. inflata*, Hall. (See Fig. 3, *c*.) *S. turgida* is further distinguished from that and all other species of the genus known to me, by the much larger zoœcia.

Position and locality: Upper beds of the Cincinnati group at Wilmington, Ill.

MITOCLEMA? MUNDULUM, n. sp.

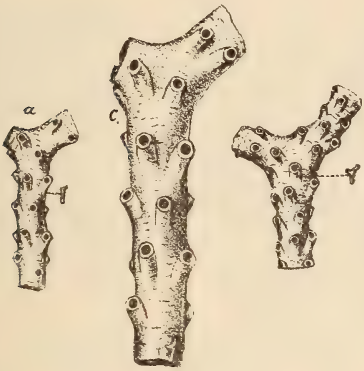

FIG. 4.—*Mitoclema? mundulum*, n. sp. *a* and *b*, two bifurcating fragments of this species, natural size, and x9. *c*, one of them x18.

Zoarium ramose, very small, the branches 0.5 or 0.6 mm. in diameter, with faint transverse striæ or wrinkles over the spaces between the zoœcia. The latter are tubular, with their apertures projecting strongly upward and outward, and not appreciably constricted. Diameter of protruding portion of zoœcium about 0.15 mm.

The interior of this species has not yet been determined because of the absence of specimens suitable for slicing. The generic position is therefore somewhat questionable, since it may prove to have the structure of *Diploclema*, Ulr., a genus including, externally, very similar forms.

Position and locality: Top of Trenton Shales, at Cannon Falls, Minn.

DIASTOPORINA, n. gen.

Zoarium bifoliate flabellate, resembling *Diastopora.* Zoœcia tubular, prostrate, not entirely immersed. Apertures constricted oblique, the anterior side not elevated. Interpaces striated. Type, *D. flabellata*, n. sp.

DIASTOPORINA FLABELLATA, n. sp.

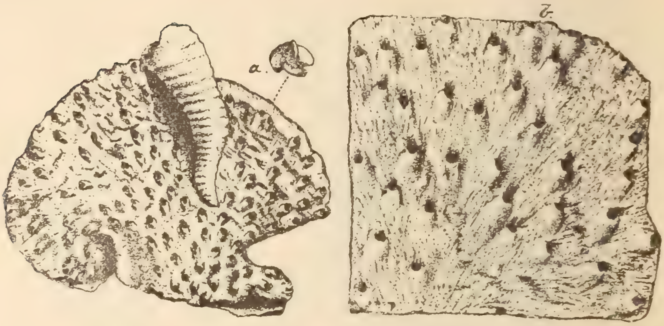

FIG. 5.—*Diastoporina flabellata*, n. sp. *a*, a complete zoarium of this species of the natural size and magnified seven diameters, showing arrangement of zoœcia, fine interstitial striæ and obscure concentric wrinkles A small tubiculous annelid is attached to the frond. *b*, portion of same x18, to show the characters of the species more clearly.

Zoarium flabellate, small, bifoliate, very thin, 5.5 mm. wide. Surface with obscure concentric wrinkles, and finely striated parallel with the direction of the zoœcia. Zoœcia rather scattering, partly exposed, appearing as convex oval spaces with a small oblique aperture, 0.05 mm. in diameter, at the distal extremity. Small, non-celluliferous spaces occasionally. Under a high power of magnification, the fine striae which cover the interpaces appear as fine lines separating rows of exceedingly minute pores.

This species is regarded as a Cyclostomatous bryozoan with relations to *Diastopora* and *Berenicea.*

Position and locality: Rare at the top of the Trenton Shales, near Cannon Falls, Minn., where it is associated with Arthroclema armatum, Helopora mucronata, Nematopora granosa and other minute Bryozoa described in this paper. The horizon is a very interesting one.

PHYLLOPORINA SUBLAXA, n. sp.

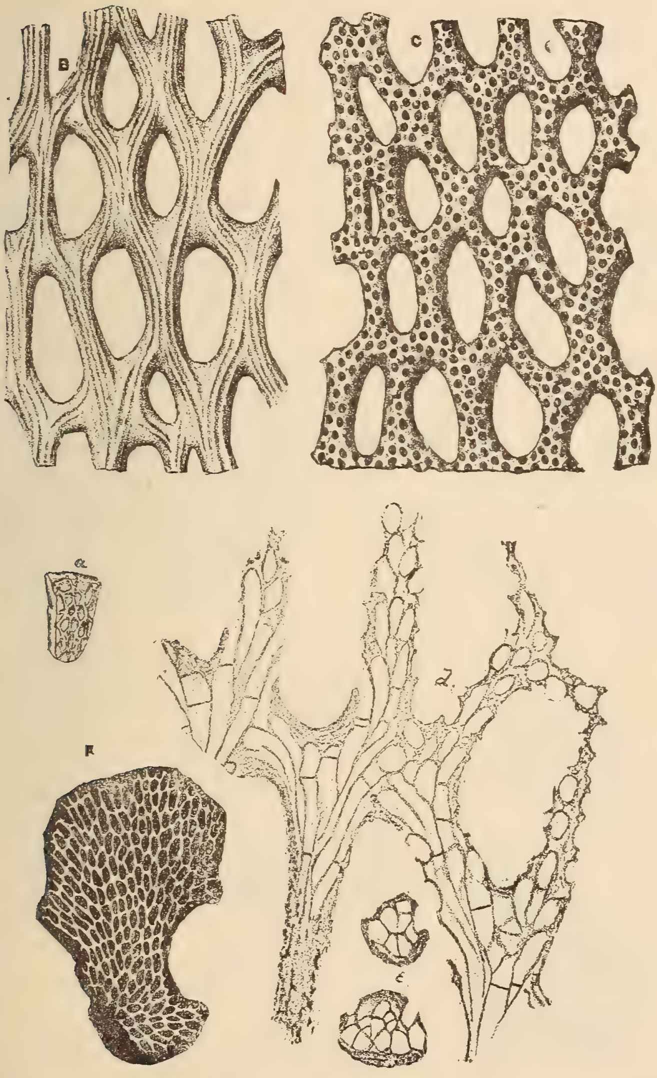

FIG 6.—*Phylloporina sublaxa*, n. sp. *a*, fragment of this species. *b*, portion of same, x9, showing strongly striated character of the reverse in young or exfoliated examples. *c*, obverse side of another specimen, x9. *d*, tangential section, x18, showing appearance of zooecia at varying depths. *e*, two transverse sections of branches, x18. *f*, a rather loosely woven example from Tennessee, natural size.

Zoarium an undulating flabelliform expansion, attaining a diameter of 5 cm. or more, consisting of irregularly inosculating slender subcylindrical branches, varying in width from 0.3 to 0.6 mm., but averaging about 0.45 mm. Fenestrules large, subacutely elliptical, generally two or three times longer than wide, but varying considerably in both dimensions; measuring longitudinally, the average number in 1 cm. is between five and six; transversely, nine or ten in the same space. These measurements are obtained from the Tennessee specimens. In the examples from Minnesota, which I refer here, the fenestrules are smaller, averaging between six and seven in 1 cm. longitudinally.

Reverse of the Tennessee specimens strongly rounded, nearly smooth, or with faint longitudinal striæ. In very young examples the latter would probably be more distinct. Fig. *b* represents an enlargement of the reverse of a small fragment obtained from near the bottom of the Mississippi River gorge, at Minneapolis, Minn., by splitting open a block of limestone. As usual under such conditions the outer layer of sclerenchyma has adhered to the opposite side of the matrix and exposed a more youthful stage in the development of the zoarium, when the reverse side was strongly striated.

Obverse face very strongly convex, carrying three rows of zoœcial apertures. These are subcircular, with a scarcely appreciable peristome, 0.09 mm. in diameter, and twenty-three to twenty-five in 5 mm. The interspaces are generally depressed, or form distinct pits between the ends of the cells. Sometimes the apertures are arranged between faintly appreciable longitudinal raised lines. Small acanthopores are usually scattered abundantly between the zoœcial apertures.

Thin sections show that the long tubular primitive portion of the zoœcia, which is moderately long and prismatic, is often intersected by from one to three diaphragms. Just before bending outward to open at the surface the tubes become rounded, leaving irregularly shaped interspaces or shallow mesopores. It is here also that the acanthopores are developed.

This fine species stands in an intermediate position between *P. trentonensis*, Nicholson, sp., and *P. granistriata*, Ul. The first is more robust, has the rows of cells more numerous and the axial portion of the zoœcia much longer. The second has more rigid branches, longer and narrower fenestrules, and the reverse of the

branches granistriate and more delicate. *P. reticulata*, Hall, sp., is a much more delicate species.

Position and locality: The Tennessee specimens are from lower Trenton limestones (Glade) at Lebanon and La Vergne. The Minnesota ones were collected from the limestones a few feet above the St. Peter's sandstone, near Minneapolis.

PHYLLOPORINA HALLI, n. sp.

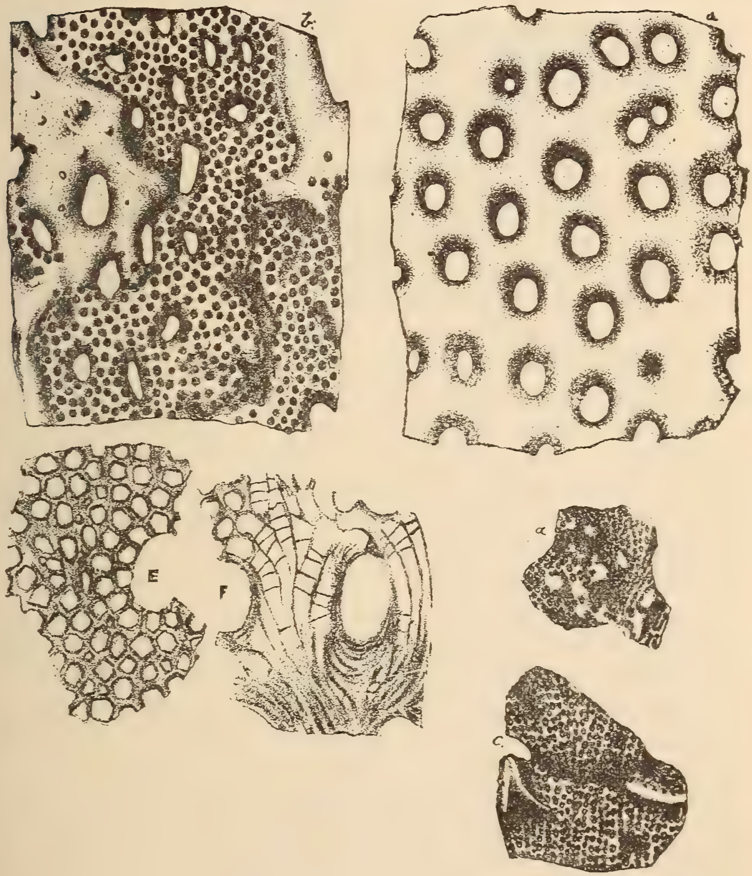

FIG. 7.—*Phylloporina Halli*, n. sp. *a*, poriferous side of specimen, natural size, showing the irregular, solid swellings. *b*, part of same x9. *c*, reverse side of another example, natural size; *d*, portion of same x9. *e*, tangential section x18, cutting the zooecia just beneath their mouths; *f*, another portion of the same section where it divides the zoarium at a deeper level.

Zoarium an undulating foliate expansion, of unknown dimensions; the largest fragment seen is 3.5 cm. in diameter; thickness of strongest varying between 1.5 and 2.0 mm. Branches scarcely distinguishable as such, the zoarium having the appearance of a perforated plate rather than consisting of inosculating branches.

Reverse with the fenestrules small, subcircular or oval, arranged more or less regularly in longitudinal and diagonal series, with from eight to ten in 1 cm. either way. When the arrangement is regular they are approximately of the same size, but when that is not the case some may be much smaller than the average. The latter are about 0.4 mm. in diameter. Over portions of old examples there may be a secondary deposit of sclerenchyma which occasionally fills the fenestrules completely. Such deposits are, however, much less frequent than upon the celluliferous face. Branches convex, smooth, with an average width of 0.65 mm. Occasionally one may be swollen to twice that width.

Obverse generally presenting a very irregular appearance. This is largely due to irregular, noncelluliferous deposits of sclerenchyma that occur at variable intervals. The fenestrules, however, also seem less regularly arranged than upon the reverse face. Surface of branches strongly convex, carrying from three to six or more rows of alternating and scarcely circular zoœcial apertures. These are about 0.9 mm. in diameter, without peristomes, and separated by intervals of less width generally than their diameter. Some of the interspaces are a little prominent. These may have contained acanthopores. Five or six cell apertures in one mm.

Although the preservation of the material is not the best for microscopical determination of internal characters, thin sections still bring to light the more salient features. They show that the zoœcial tubes are intersected by numerous diaphragms; that near their apertures they are still prismatic, resembling the zoœcia of a Monticuliporoid, and that a few small cells, perhaps acanthopores, are scattered among the true zooecia.

This is an easily recognized species, being also quite distant from all the others of the genus known. In its proportions it is somewhat like *P. corticosa*, from the same horizon, but they are not likely to be confounded, the strong carinae on both sides of the branches in that species serving amply in distinguishing them.

The specific name is given in honor of Prof. C. W. Hall, of the State University of Minnesota, who is taking a lively interest

in the collection and determination of the Silurian fossils of Minnesota, and to whom I am indebted for many favors.

Position and locality; Upper part of the Trenton Shales, at St. Paul, Minn., where they were collected by the author.

RHINIDICTYA MINIMA, n. sp.

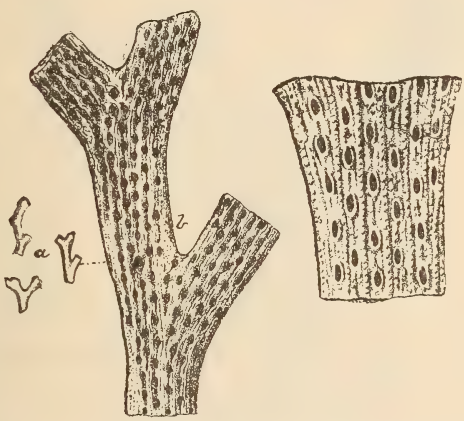

FIG. 8.—*Rhinidictya minima*, n. sp. *a*, three fragments of the natural size; *b*, one of them x9; *c*, portion of same x18, to show narrow zoœcial apertures and surface ornamentation more clearly.

Zoarium bifoliate, small; branches about 1.0 mm. wide, bifurcating at intervals of from 2 to 3 mm. Zoœcia in five or six alternating longitudinal rows between the bifurcations where the branches have parallel margins. Apertures narrow, elliptical, small, 0.11 mm. long, about half as wide, with sixteen in 5 mm. longitudinally; margin of apertures thin and slightly elevated; interspaces unusually wide, sometimes appearing flexuously striate, usually with a distinct, granose, longitudinal line between the rows of zoœcia and one or two short ones in the slightly depressed spaces between the ends of the zoœcial apertures. Margin of branches acute, the noncelluliferous band rather wide and occupied by one or more lines of granules.

This pretty little species is easily recognized by its widely separated narrow zoœcial apertures, and the granulo-striate character of the interspaces. Its branches also divide with unusual frequency.

Position and locality: Top of Trenton Shales, at Cannon Falls, Minn., where it is associated with numerous other small Bryozoa.

RHINIDICTYA EXIGUA, n. sp.

FIG. 9.—*Rhinidictya exigua*, n. sp. *a*, basal portion of zoarium, natural size and x9: near the base the zoœcial apertures mostly closed by a secondary deposit; *b*, a very narrow specimen with only three rows of cell apertures; *c*, a wide example, having five and six rows; *d*, lower portion of same x9.

Zoarium bifoliate, small; branches, except near the base, thin and very slender, their width varying between 0.5 and 1.0 mm.; bifurcating at intervals of 5 or 6 mm. Basal portion of zoarium subcylindrical, and with the zoœcial apertures largely filled with a smooth, solid deposit of sclerenchyma. The branches, however, soon become flattened and sharp-edged, but at no time is there more than just an appreciable noncelluliferous border. Above the first bifurcation the branches are acutely elliptical in cross section, and exhibit from three to six rows of zoœcia on each face. The apertures of the zoœcia are impressed subelliptical or subquadrate, those in the central rows 0.2 mm. long by 0.1 mm. wide, those in the marginal rows oblique and often a little larger, all regularly arranged longitudinally, seventeen or eighteen in 5 mm. Interspaces very thin, about equal at the sides and ends of the zooecial apertures, smooth (without granules) so far as observed.

The characters relied upon in distinguishing this species are its narrow branches, thin interspaces, small zooecia and comparatively large apertures. It is closely related to *R. paupera* (*Stictopora*

paupera, Ulrich) occupying a higher horizon in the shales. *R. mutabilis*, Ulr., a much larger species, is associated.*

Position and locality: Lower beds of the Trenton Shales at Minneapolis, Minn., and vicinity.

RHINIDICTYA HUMILIS, n. sp.

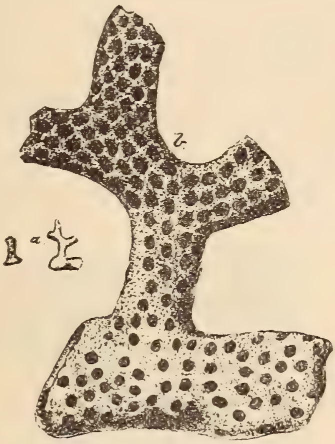

FIG. 10.—*Rhinidictya humilis*, n. sp. *a*, two specimens of the natural size, both preserving the basal portion. *b*, the largest x9, showing the arrangement of the zoœcia, granulose interspaces, and frequent bifurcation of the zoarium.

Zoarium bifoliate, dwarfish; branches strongly convex, 1.0 mm. or a little less in width, arising from a strong basal expansion, and bifurcating at intervals of about 2 mm. Zoœcia in from three to five ranges, their apertures impressed subcircular, 0.12 mm. in diameter, widely separated and irregularly arranged over the basal portion, but almost crowded near the distal extremities of the branches. The arrangement of the apertures is either in longitudinal rows or in quincunx. When the latter arrangement prevails, seven apertures may be counted in 2 mm., measuring along one of the oblique rows. Interspaces of variable width, more than equal to the diameter of the zoœcial apertures on the basal expansion, but gradually becoming narrower upward till just beyond the first bifurcation, after which they are subequal and usually about half as wide as the zoœcia mouths; carrying an abundance of

*The Tennessee species, *Bythopora nashvillensis*, Miller, which is a bifoliate bryozoan and not a *Bythopora* at all, but belongs to *Rhinidictya*, is also related, but is distinguished by its more convex branches, smaller cell apertures and thicker interspaces.

small papillae. Nonporiferous margins granulose, obsolete above the first bifurcation.

The dwarfish appearance of this species distinguishes it from *R. nicholsoni*, Ulr. That species has much wider branches bifurcating at very long intervals. The growth is like in *R. minima*, but the two species are quite different in other respects, the differences in the size of the zoœcia apertures and in the markings of the interspaces being especially striking.

Position and locality: From the lower beds of the Trenton Shales, associated with *Stictoporella frondifera* and *Pachydictya foliata*, at Minneapolis, Minn.

PACHYDICTYA PUMILA, n. sp.

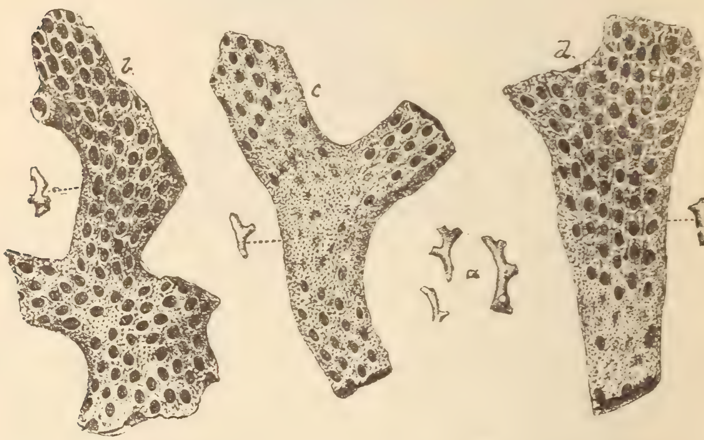

FIG. 11.—*Pachydictya pumila*, n. sp. *a*, three specimens of the natural size. *b*, a small specimen preserving the base, natural size, and x9. In this specimen the surface is well preserved and all the zoœcial apertures open. *c* and *d*, two fragments, natural size, and x9, with many of the apertures closed by a granulose secondary deposit.

Zoarium bifoliate, small; branches from 1.0 to 1.5 mm. wide, bifurcating at frequent intervals. Zoœcia in from four to six longitudinal rows, with about seven in 2 mm. Apertures elliptical, averaging about 0.15 mm in length, and 0.1 mm. in width, enclosed by a very thin peristome. Interspaces slightly depressed or flat, and, like the moderate non-celluliferous margins, filled with small papillae. It happens frequently that these papillae extend over large patches of the surface where the zoœcial apertures have been closed by a thin deposit of calcareous material. In very young examples, or at the distal extremities of the branches

of more mature ones, the longitudinal interspaces between the zoœcial apertures may show one or two pits or vesicles.

Internal structure in conformity with that required by the genus.

Pachydictya triserialis, the next described, is the only other very small species of the genus known to me. These two can not be confounded. *P. acuta*, Hall, is larger in every respect. None of the other species are closely related. It is associated with *Rhinidictya minima*, Ulr., but as soon as the differences have been grasped they will be distinguished at once.

Position and locality: Top of Trenton Shales, at Cannon Falls, Minn., associated with numerous other small Bryozoa.

PACHYDICTYA TRISERIALIS, n. sp.

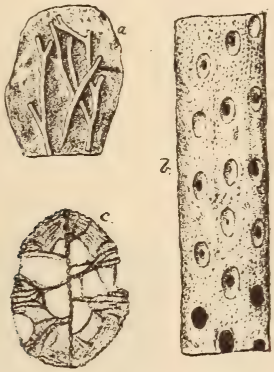

FIG. 12.—*Pachydictya triserialis*, n. sp. *a*, small portion of a piece of Trenton limestone showing several of a group of branches of this species, all belonging to a single zoarium. *b*, portion of one of the branches x18, showing the arrangement of the three rows of zoœcia and the minutely granulo-striate character of the interspaces. Most of the zoœcial apertures are closed by perforated or entire opercula-like structures. *c*, transverse section of a branch x25, showing the median tubuli along the divisional central line.

Zoarium, consisting of very slender, parallel-margined and but little compressed branches, bifurcating at intervals of from 5 to 10 or more mm. Branches oval, or obtusely hexagonal in cross-section, the margins never being acute, and at the most may sometimes be described as narrowly rounded. Each face with three rows of longitudinally-arranged zoœcial apertures. The latter are elliptical, about 0.2 mm. long and 0.1 mm. wide, surrounded by a scarcely appreciable peristome, and often preserve centrally perforated covers; the interspaces between the ends of the apertures are longer than usual, and only eleven apertures

occur in 5 mm. measuring longitudinally. Interspaces occasionally subangular between the rows of zoœcia; everywhere exhibiting a very fine granulo-striate character. Non-periferous margins inconspicuous, generally wider on one side than on the other.

The subhexagonal narrow branches of this species present considerable resemblance to species of *Nematopora* like *N. lineata* (*Helopora lineata*, Billings). Of course, there is no real affinity between them, this being, as is clearly shown by transverse sections, a bifoliate zoarium, while in *Nematopora* the zooecia diverge equally in all directions from the center of the branch. I am not acquainted with any species of *Pachydictya*, nor with any associated species of bryozoan, with which the slender ramulets of *P. triserialis* might be confounded.

Position and locality: Trenton limestone, Montreal, Canada. The specimens, together with other Bryozoa, received in exchange from the Peter Redpath Museum, were collected by Mr. T. C. Curry.

STICTOPORELLA RIGIDA, n. sp.

FIG. 13.—*Stictoporella rigida*, n. sp. *a*, a bifurcating branch of this species, natural size, and part of same x9. *b*, portion of same x18, showing the arrangement of the zoœcia apertures, interstitial pits or mesopores, and character of margins.

Zoarium a narrow branching, bifoliar stipe. Branches flattened, 1.0 mm. or a little more wide, with straight parallel and sharp margins, acutely elliptical in cross-section. Zoœcia in seven to nine or ten rows on each face, their apertures arranged in very regular longitudinal and diagonally intersecting series, with six-

teen or seventeen in 5 mm. lengthwise and four in 1 mm. obliquely. Apertures elliptical, 0.2 mm. long, half that wide, impressed, the sloping area narrow for this genus, and appearing sometimes a little oblique because of a slight elevation of the posterior border; those in the marginal rows are directed slightly outward. Between the ends of succeeding zoœcial apertures one or two small mesopores. There is usually a row of these small pores along the border of the branches. Interspaces narrowly rounded or ridge-shaped, comparatively thin.

This is a handsome and easily recognized species, *S. interstincta*, Ulr., from the Utica horizon of the Cincinnati group, and the only species of the genus with which it need be compared, has more numerous mesopores, wider branches, and much wider sloping areas about the smaller zoœcial apertures. I have described three other species of this genus from the Trenton Shales of Minnesota, and there is yet another that remains undescribed. *S. angularis* has wider branches, has numerous mesopores and much thicker ridge-shaped interspaces between the zoœcial apertures. *S. frondifera* grows into broad fronds and has zoœcia like those of *S. angularis*. *S. cribrosa* forms cribrose zoaria resembling those of *Clathropora*.

Position and locality: Rare in the Trenton Shales at Fountain, Minn.

ARTHROSTYLUS CONJUNCTUS, n. sp.

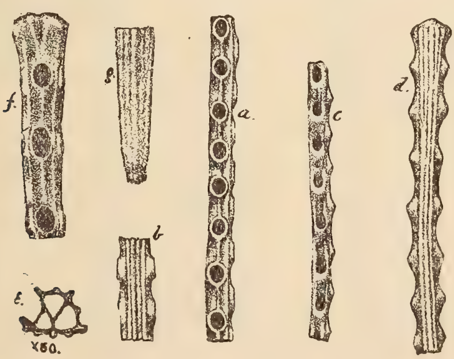

FIG. 14.—*Arthrostylus conjunctus*, n. sp., and *A. obliquus*, n. sp. *a*, lateral view of central portion of segment of *A. conjunctus* x18. *b*, view of portion of non-celluliferous side of same. *c*, lateral view of central portion of segment of *A. obliquus*, x18, *d*, non-celluliferous side of same, showing about three-fourths of the segment with the upper extremity, x18. *e*, transverse section of *Arthrostylus tenuis*, James, sp., x50. *f*, obverse side of upper end of segment of same, magnified twenty-eight diameters.

Zoarium jointed; segments very slender, straight, needle-shaped, 3 or 4 mm. long, quadrangular in cross section, 0.25 mm. wide, 0.18 mm. thick, with zoœcial openings on three sides, the fourth being without them, but marked instead with four parallel longitudinal striæ. Zoœcial apertures broad-oval, direct, 0.11 mm. long, 0.09 mm. wide, enclosed by a sharply marked peristome. Peristomes of each row of apertures joined together by a thin ridge, having a length about equal to the larger or outer diameter of the peristomes. Eight zoœcial apertures in each row in 2.5 mm. A thin ridge, on each side of the range of apertures of the obverse face of the segment, separates it from the lateral rows. Apertures usually arranged alternately in the three rows.

This species is closely related to *A. tenuis*, James, sp., but is distinguished by having the non-celluliferous side narrower and with fewer striæ, causing transverse sections to be more nearly square. The *A. obliquus* differs in having oblique zoœcial apertures.

Position and locality: Base of Trenton Shales, near Minneapolis, Minn.

ARTHROSTYLUS OBLIQUUS, n. sp. Fig 14, *c*, *d*.

Zoarium jointed, segments very slender, needle-shaped, straight or slightly curved, about 4 mm. long, subquadrangular in cross-section, 0.2 mm. wide, 0.15 mm. thick, slightly expanding toward the upper extremity. Zoœcia in three rows occupying as many faces of the segment, the fourth side with three longitudinal striæ, and no zoœcia. Profile of a segment on an obverse or reverse view, wavy on both sides; on a lateral view only on one side.

Zoœcial apertures small, oblique, the posterior margin very prominent, arranged alternately in the three rows, with nine in each, in 2.5 mm. A short ridge from the upper depressed edge of each zoœcial aperture is flanked on each side by the prolonged lateral borders of the aperture. No ridge between the lateral and central row of the zoœcia.

The oblique zoœcial apertures, the prominent lower border and absence of ridges between rows of apertures, distinguish this species from *A. conjunctus* and *A. tenuis*, both of which it resembles in other respects.

Position and locality: Trenton Shales, Minneapolis, Minn. Rare.

HELOPORA, Hall.

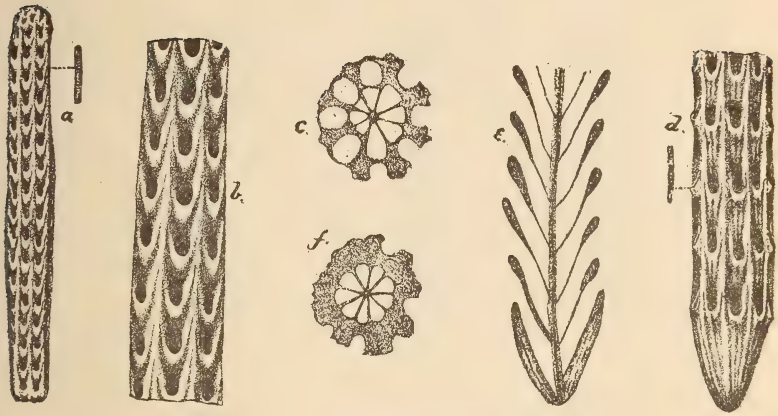

FIG. 15.—Illustrating species of *Helopora*. *a, b* and *c*, *H. divaricata*, Ulrich, Trenton Shales, Minneapolis, Minn. *a*, segment, natural size, and x7. *b*, portion of same x18. *c*, transverse section x18. *d, e* and *f*, *H. spiniformis*, Ulrich, Birdseye limestone, Lebanon, Tenn. *d*, a segment of the natural size, and its lower half x18. *e*, vertical section of lower half. *f*, transverse section x18.

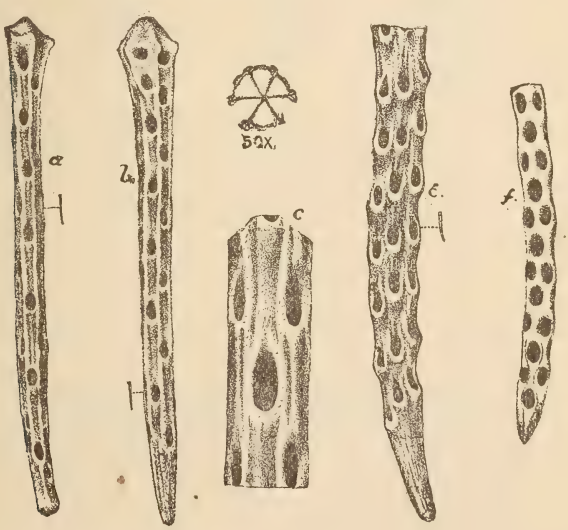

FIG. 16.—Illustrating species of *Helopora*. *a* and *b*, two complete segments of *H. harrisi*, James, x18, from the upper beds of the Cincinnati group, at Waynesville, O. *c*, portion of one x50. *d*, transverse section of a segment x50, showing six rows of zoœcia. *e*, a segment of *H. mucronata*, n. sp., and most of it magnified to eighteen diameters, showing its slight curve, tapering form, the arrangement of the zoœcial apertures and striæ above each. *f*, the lower and most of the upper half of a segment of *H. alternata*, n. sp., x18.

HELOPORA ALTERNATA, n. sp. Fig. 16, *f*.

Zoarium jointed; segments exceedingly slender, slightly curved, about 3.0 mm. long, and 0.5 mm. in diameter; lower extremity obtusely pointed. Zoœcia apertures oval, direct, impressed, comparatively large, 0.14 mm. long, arranged alternately, four in each cycle, twelve cycles in 2.5 mm. Interspaces rather thin, generally appearing simply rounded. On the segment illustrated two faint impressed lines wind between the apertures near the base.

The very thin segments, and large alternately or quincuncially arranged zoœcia impart to this species a very characteristic and easily recognized appearance.

Position and locality: Base of Trenton Shales, Minneapolis, Minn.

HELOPERA MUCRONATA, n. sp. Fig. 16, *e*.

Zoarium jointed. Segments spine-like, slightly curved, 3.5 to 4.0 mm. long, tapering downward from a diameter of 0.6 or 0.7 mm. to the acute and finely striated basal extremity. Zoœcia apertures oblique, the inferior and lateral margins elevated, arranged longitudinally and spirally with about seven in one volution, and six in 2.5 mm. lengthwise. At the upper side of each aperture there are two short striae, which become obsolete as they pass into the cell mouth.

The curved and tapering form, acute, striated, lower extremity, and spiral arrangement of the zoœcial apertures distinguish this species from all others of the genus known.

Position and locality: Top of Trenton Shales, Cannon Falls, Minn.

ARTHROCLEMA, Billings.

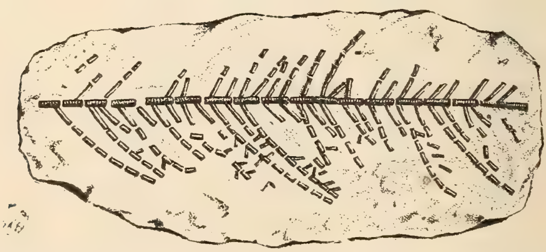

FIG. 17.—*Arthroclema Billingsi*, Ulrich. A nearly complete example of this species, from the Trenton limestone at Ottawa, Canada, introduced to illustrate the mode of growth prevailing in this genus. The species is described in Vol. VIII., Reports Geological Survey of Illinois, p. 642 (in press). (NOTE.—This figure is turned sideways to adjust it to the length of the page.—ED.)

ARTHOCLEMA CORNUTUM, n. sp.

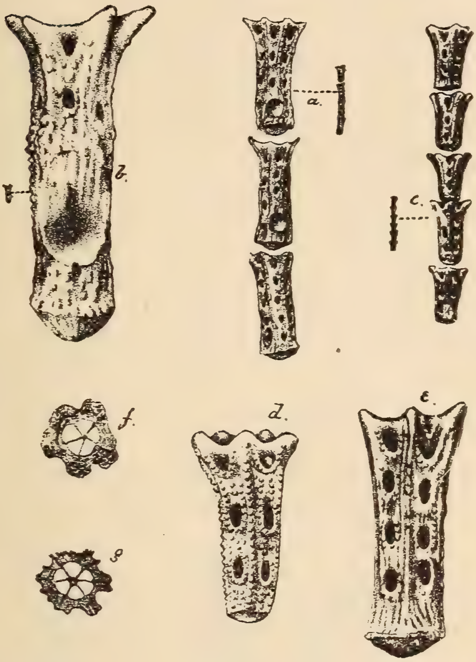

FIG. 18.—*Arthroclema cornutum*, n. sp. *a*, four of the primary segments in connection, with three x7, showing the articulating sockets near the base of each, and the usual appearance of the segments of this series; *b*, a very perfect primary segment, natural size and x18, showing unusually deep socket, and the irregular granulations of the surface; *c*, a series of six segments of the secondary order, and five of them x7; the segments of this order are without articulating sockets, and may have either three or four cycles of zoœcia; *d*, secondary segment with three cycles of zoœcia x18, showing granose ornamentation and other characters; *e*, larger and differently marked secondary segment with four cycles of zoœcia x18; *f*, transverse section of secondary segment from near its upper extremity, showing five rows of zoœcia x18; *g*, transverse section of primary segment, from near its lower extremity, showing six rows of zoœcia x18.

Zoarium jointed, the segments consisting, so far as known, of only a primary and a secondary series. Primary segments, six-sided, about 2.2 mm. long, and 0.7 mm. in diameter, with the six angles, more or less sharply defined and produced at the truncated upper extremity into as many horn-like projections. Near the lower extremity, which is often a little bulbous and radially striated, usually two subcircular articulating sockets, placed one on each of two opposite faces of the segment. Zoœcia generally in four, rarely in five cycles, the apertures of those of the uppermost

cycle more oblique than the others, and situated very near the upper extremity of the segment. Angles of segments, peristomes of the oval zoœcial apertures, and longitudinal interspaces between them, more or less regularly papillose. Secondary segments 1.5 to 1.8 mm. long, about 0.45 mm. in diameter, generally with only three cycles of zoœcia, and without articulating sockets. Otherwise very similar to those of the primary set. The papillose ornamentation of the surface is, however, generally more regular.

The neat little detached segments of this species are rather plentiful on the limestone slabs of the lower portion of the Trenton Shales, near the State University at Minneapolis, Minn. A larger segment of another species that is more closely related to *A. pulchellum*, Billings, is occasionally found with them. It is not at all likely that they will be confounded. The next described species (*A. armatum*) is a nearer relative, but readily distinguished by its larger segments and prominently produced lower border of its zoœcial apertures.

ARTHROCLEMA ARMATUM, n. sp.

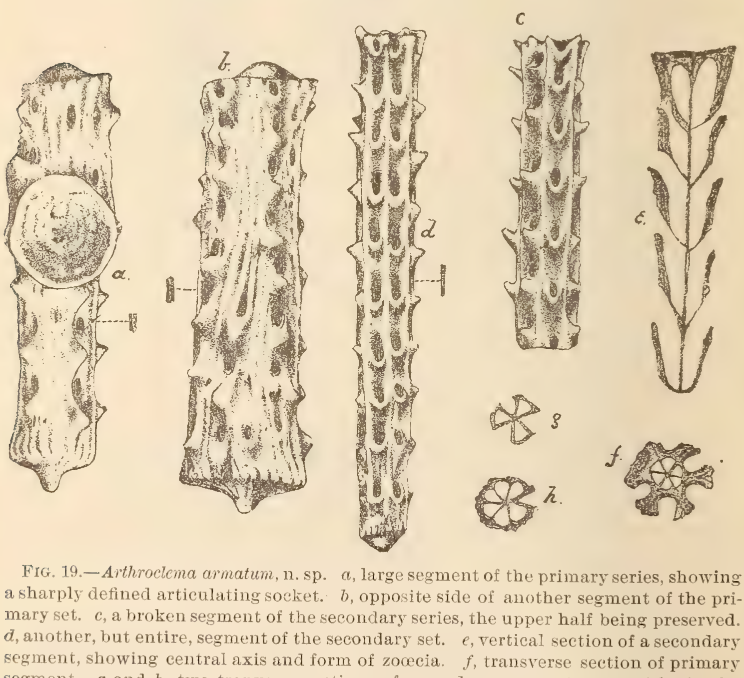

FIG. 19.—*Arthroclema armatum*, n. sp. *a*, large segment of the primary series, showing a sharply defined articulating socket. *b*, opposite side of another segment of the primary set. *c*, a broken segment of the secondary series, the upper half being preserved. *d*, another, but entire, segment of the secondary set. *e*, vertical section of a secondary segment, showing central axis and form of zoœcia. *f*, transverse section of primary segment. *g* and *h*, two tranverse sections of secondary segments, one with six the other with seven rows of zoœcia. All the figures are magnified eighteen diameters.

Zoarium jointed, so far as known consisting of primary and secondary segments only. Primary segments, from 3 to 5 mm. long, 0.5 to 1.0 mm. in diameter, the thickest generally the longest, and always with a well-marked socket for articulation with the first of the secondary segments. Only one socket on any segment, and some of them are without any. The socket is situated generally a little above the center of the length. Some of the joints of this set are decidedly compressed or irregularly shaped, and all more or less distinctly striated longitudinally. Both ends truncate, but with the central portion of the upper convex, and the lower more acutely drawn out. Zoœcia usually in six ranges, their apertures oval, nearly direct, 0.1 mm. long, with about seven in each range in 2.5 mm.; a strong tubercle just behind or near each aperture.

Secondary segments of about the same length as those of the primary set. They are, however, more slender, none being more than 1.5 mm. in diameter, and the smallest ones only about 0.3 mm. Upper end terminating abruptly, spinous, lower end rounded. Zoœcia is six and sometimes seven, rows arranged between longitudinal ridges that become stronger with age; a transverse arrangement also usually prevails; apertures oblique, with the inferior border very prominent, spine-like, seven in 2.5 mm.

Mature and well-preserved segments of this species could not well be confounded with any other jointed bryozoan known to me. Immature joints of the secondary series must be examined with some care, to separate them from the segments of the associated *Helopora mucronata*. In that species the segment enlarges gradually from the pointed inferior end, the zoœcial apertures are not arranged between longitudinal ridges, and above each aperture there are two thin striæ, which are wanting in this species. The spine-like prominence of the inferior margin of the zoœcial apertures serves sufficiently in distinguishing *A. armatum* from the other species of the genus.

Position and locality: Top of the Trenton Shales, at Cannon Falls, Minn., where it is associated with numerous other small bryozoa.

NEMATOPORA GRANOSA, n. sp.

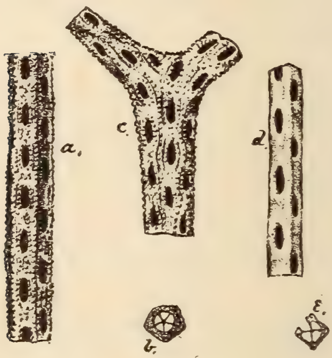

FIG. 20.—*Nematopora granosa*, n. sp. *a*, unbranched fragment x18, with five rows of zoœcia, showing the granulose angles and interspaces, and narrow zoœcial apertures. *b*, end view of same. *c*, bifurcating fragment x18, with the rows of granules slightly flexuous. *d*, slightly worn fragment with only four rows of zoœcia. *e*, end view of same.

Zoarium ramose; branches bifurcating at rather long intervals, from 0.25 to 0.38 mm. in diameter, the smallest quadrangular in cross-section and with only four rows of zooecia; those of the average size, pentagonal, and with five rows of cells. Zoœcial apertures small, narrow, about seven in each range in 2.5 mm., enclosed by a series of minute granules. Longitudinal interspaces with a small number of similar granules. Rows of apertures separated by more or less well-developed straight or slightly flexuous granulose ridges.

The papillose ornamentation and narrow zoœcial apertures of this species distinguish it from all the others known to me. There is considerable external resemblance to small species of *Rhombopora* like *R. lineinodis*, Ulr., and *R. regularis* (*Trematopera regularis* and *Orthopora regularis*, Hall), but not much in the more important internal characters.

Position and locality: Top of Trenton Shales, Cannon Falls, Minn.

NEMATOPORA OVALIS, n. sp.

FIG. 21.—*Nematopora ovalis*, n. sp. *a*, fragment of the natural size and x18, with five ranges of zoœcia. *b*, another with more ridges, only four rows of zoœcia, and the apertures less closely arranged.

Zoarium ramose; branches bifurcating at intervals of about 2 mm., 0.3 to 0.4 mm. in diameter, subquadrangular or pentagonal in cross-section, each face with a row of zoœcia. Zoœcial apertures direct, very large, oval, nearly 0.3 mm. long by 0.15 mm. wide, enclosed by a sharply defined peristome. A short ridge joins the peristomes of each row of apertures, and longitudinally divides the concave spaces between the ends of the apertures. These spaces are larger in the subquadrate examples than in those having five rows of zoœcia. They also have the thin ridge that bounds each face more distinct from the elevated margins or peristomes of the zoœcial apertures, which, in the pentagonal specimens, to a large extent also form the border of the faces. Longitudinal interspaces generally shorter than the length of the zoœcial apertures; about five of the latter in 2.5 mm.

The large zoœcial apertures serve to distinguish this species from all the others known to belong to the genus. Under the microscope the general appearance of the zoarium is strikingly different from that of *N. granosa*, with which it is associated.

Position and locality: Top of Trenton Shales, Cannon Falls, Minn.

NEMATOPORA CONFERTA, n. sp.

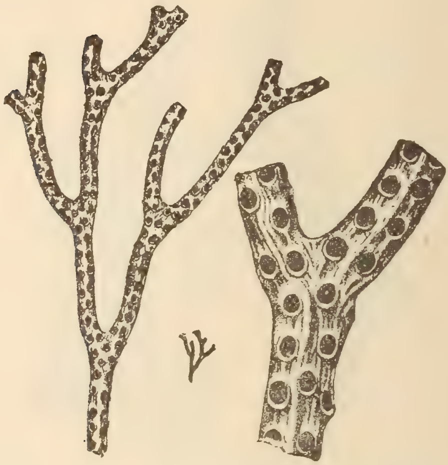

FIG. 22.—*Nematopora conferta*, n. sp. Zoarium of this species, natural size, x9, and portion of same magnified eighteen diameters.

Zoarium ramose; branches dividing dichotomously at intervals of about 2 mm., 0.4 to 0.5 mm. in diameter, subcircular in cross-section. Zoœcia in five or six longitudinal ranges, their apertures subcircular or broad-oval, frequently arranged also in rows encircling the stems; slightly oblique, surrounded by a thin peristome, strongest and most elevated posteriorly; diameter of apertures 0.15 mm., separated by intervals, longitudinally, greater than the diameter, between seven and eight in 2.5 mm. Interspaces striated, occasionally rising into ridges which separate the longitudinal ranges of zoœcial apertures for a short distance.

The smaller, subcircular apertures and simply striated interspaces distinguish this species from *N. ovalis*. *N. alternata*, Ulr., from the Galena or Upper Trenton of Southern Illinois, has the zoœcial apertures arranged in quincunx. In *N. retrorsa*, from the same locality and formation, they are ranged between longitudinal ridges.

Position and locality: Top of Trenton Shales, Cannon Falls, Minn.

IN MEMORIAM.

DIED.—AT MANITOU SPRINGS, COLORADO, DECEMBER 8th, 1889, GEORGE S. HUNTINGTON.

George Spencer Huntington, son of Thos. W. and Frances Williamson Huntington, was born in Cincinnati March 20th, 1850. His mother, Frances E. Williamson, was a member of an old Cincinnati family, and his father was a descendant of Samuel Huntington, one of the signers of the Declaration of Independence. George was educated in the public schools, and graduated from Woodward High School, taking the gold medal for proficiency in mathematics. He studied engineering with his father, who built the C., H. & D. and K. C. R. R. George was afterward one of the engineers of the Cincinnati Southern Railroad.

The unfortunate accident which caused his death occurred on Pike's Peak, Colorado, December 2d, where he was engaged in building a railroad to the top of this lofty peak. He was a devoted student of Natural History, and his work in preparing and arranging insects, shells and fossils was a model of neatness and accuracy. Only recently he presented his collections to this Society. He was an expert photographer, and a member of the Photographic Section.

A true and faithful father, brother and friend, we deeply deplore his untimely death, and cherish his memory.

Respectfully submitted,

CHARLES DURY,
GEO. W. HARPER, *Committee.*
H. P. SMITH,

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Special attention is requested to this department. Valuable scientific communications are often given in letters which never appear in print, and unless such letters are preserved, the information may be lost. Persons having letters and manuscripts of scientific value which they are willing should be placed on file, are respectfully invited to send such communications to the library of this Society.

E. F. Crooks. On Belding Bros.' Artesian Well. Presented by Dr. O. D. Norton.

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Prof. Joseph F. James. On Oxford Gas Well.

Prof. A. P. Morgan. On Sullivant's Book of Mosses. Presented by Davis L. James.

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H. T. Patton. On Wild Oats. From Dr. O. D. Norton.

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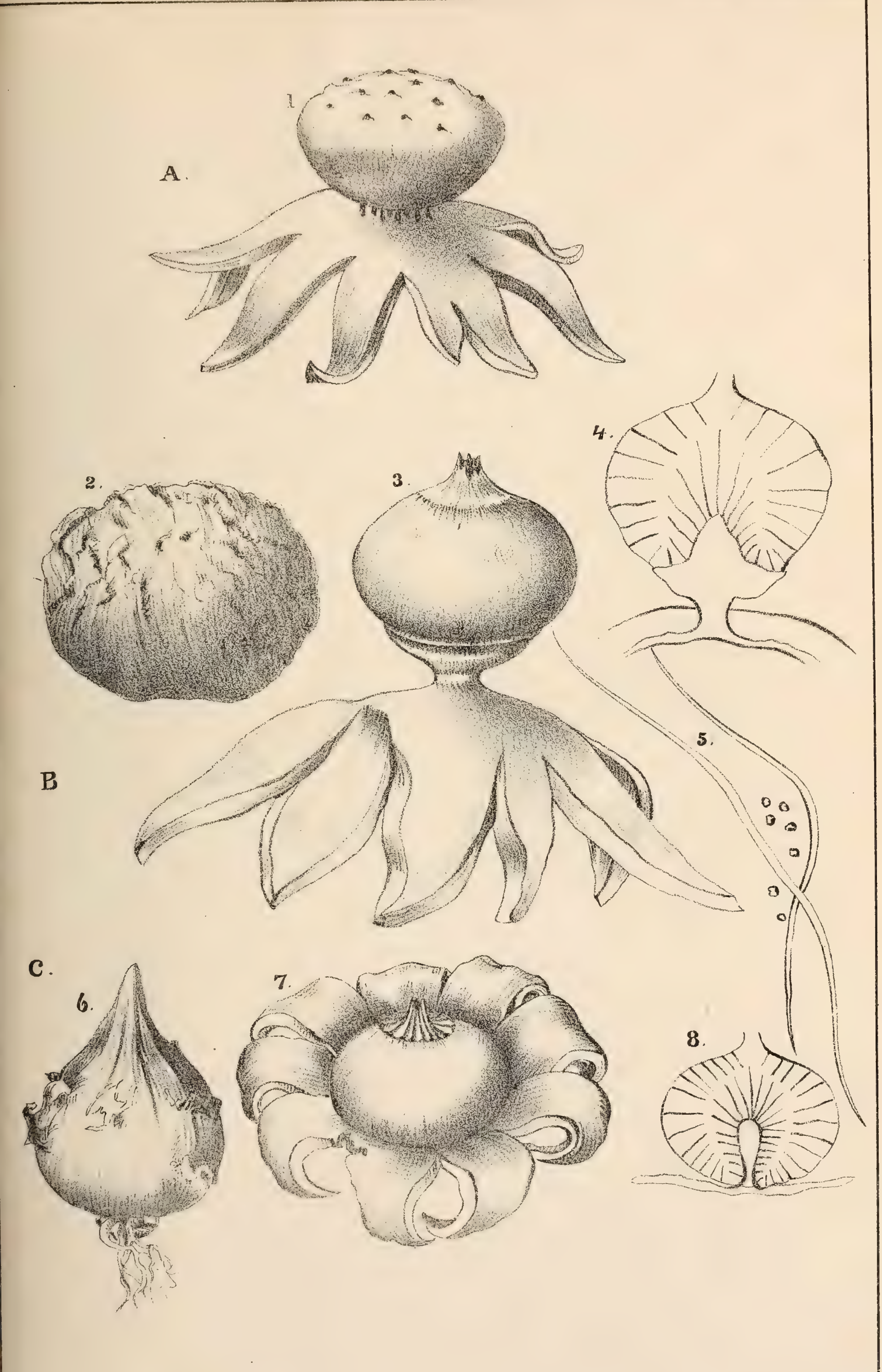

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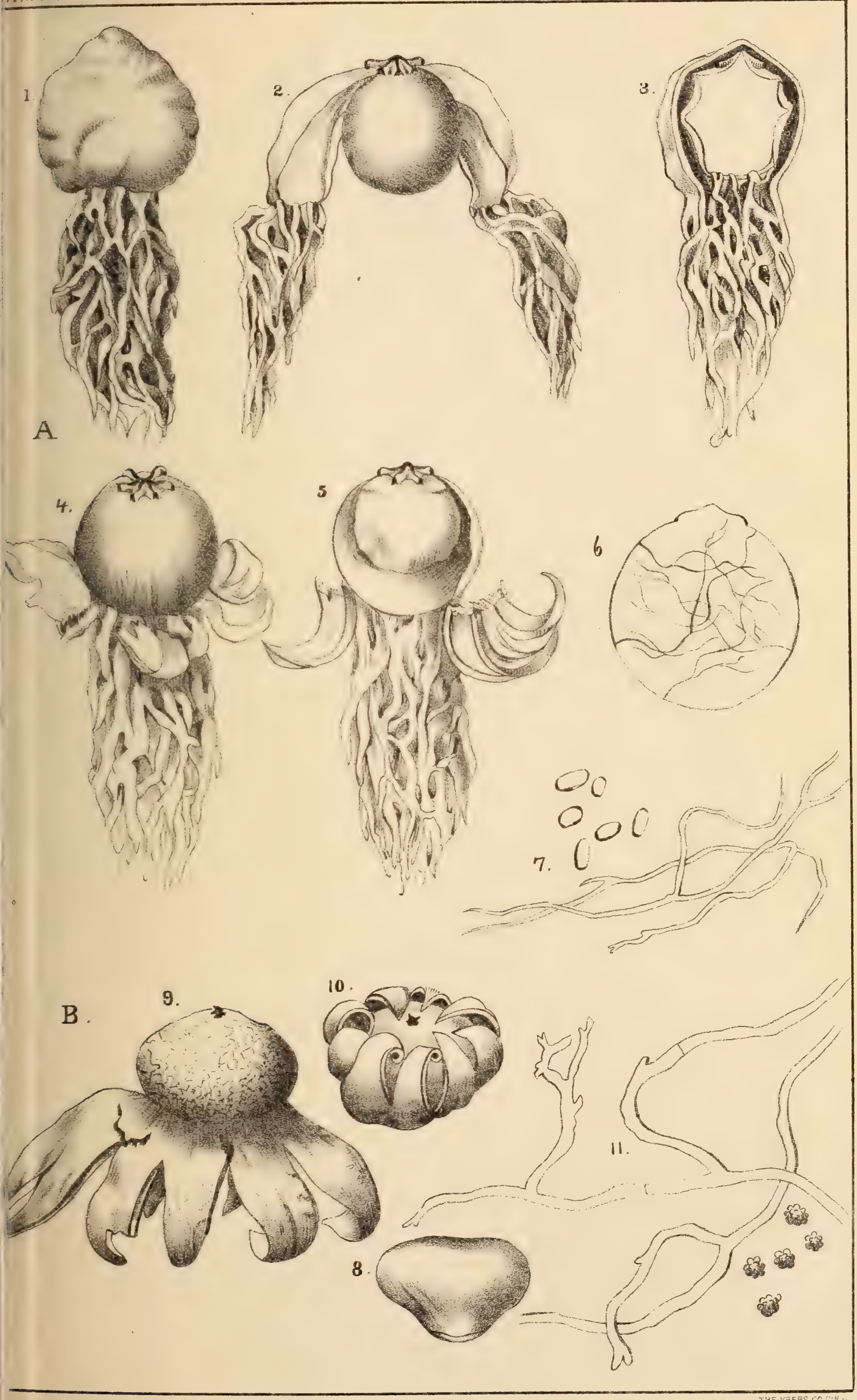

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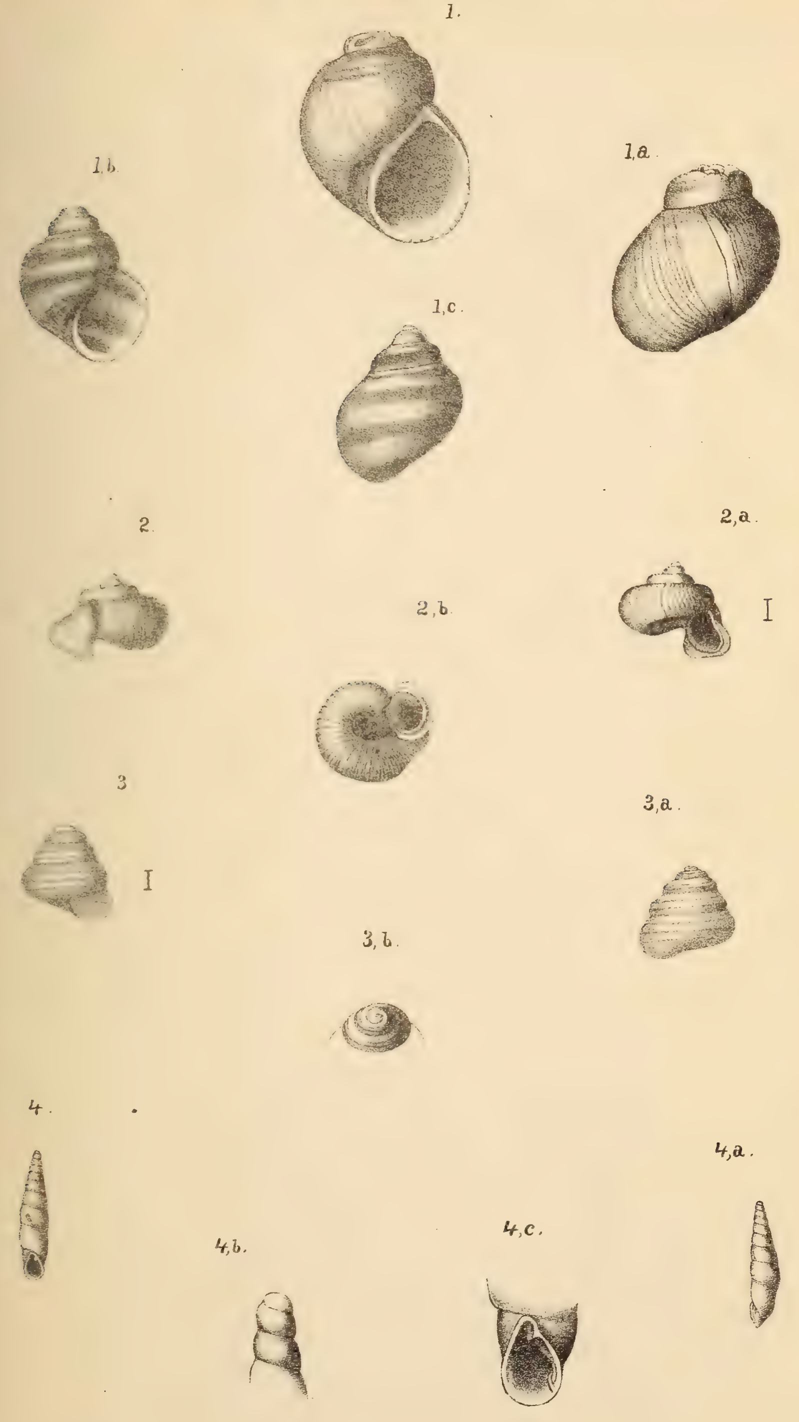

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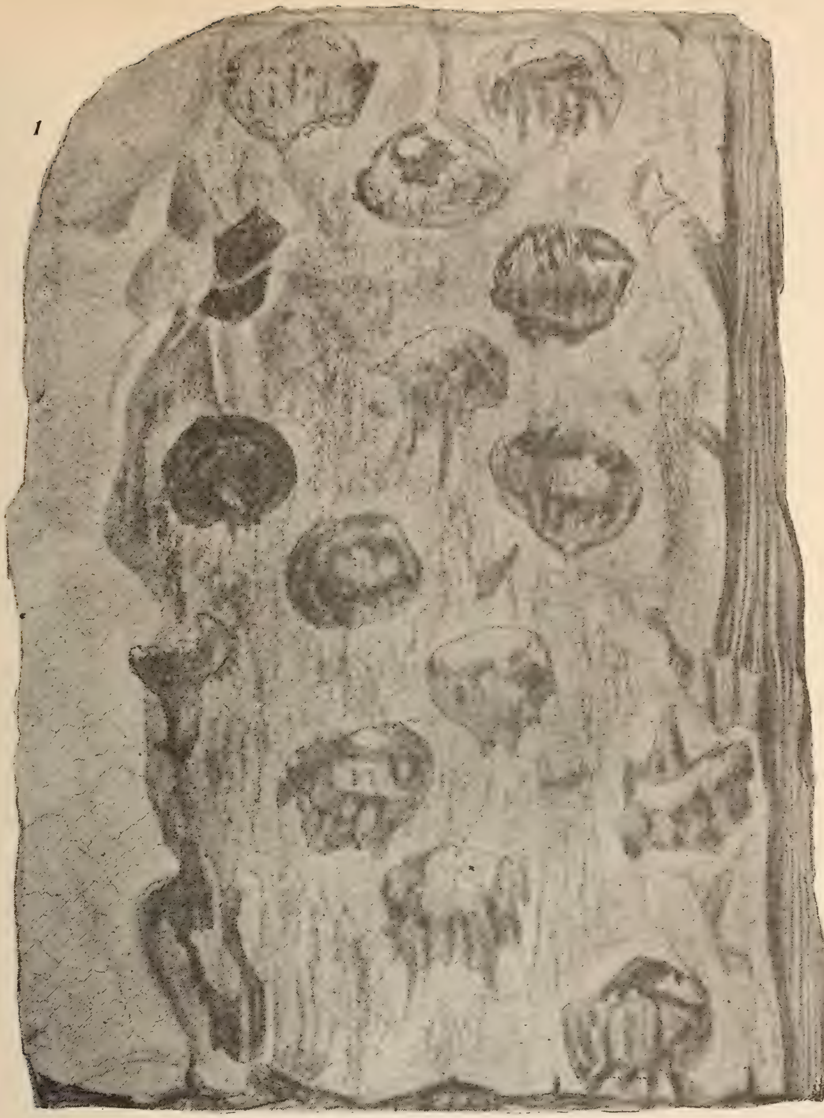

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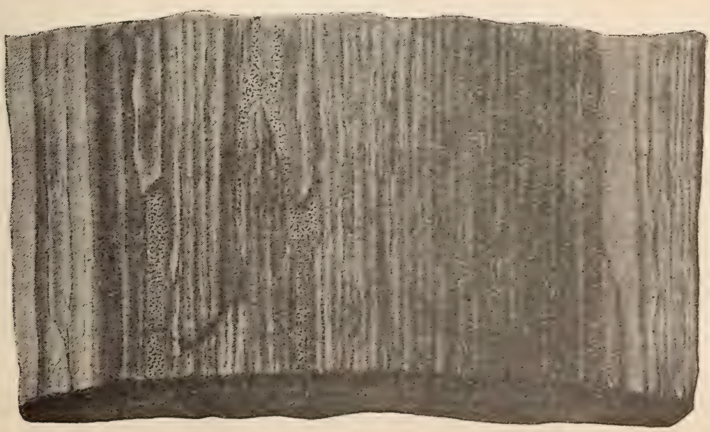

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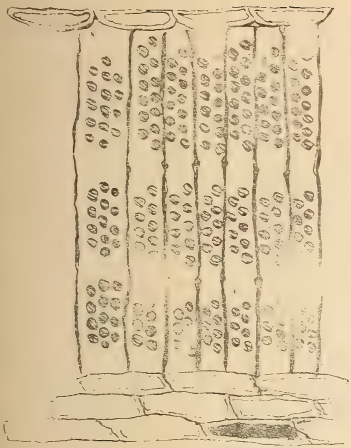

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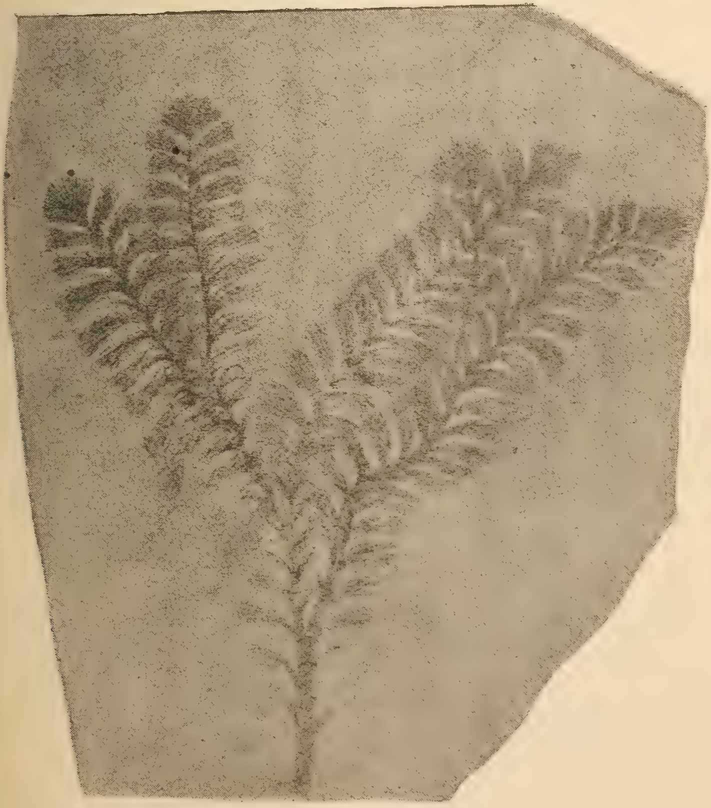

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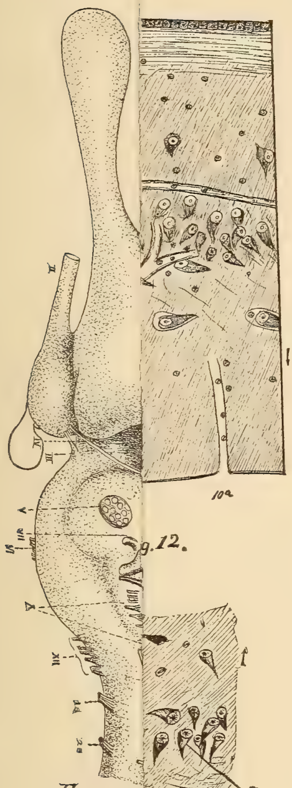

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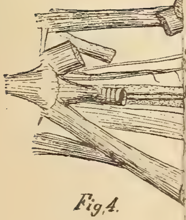

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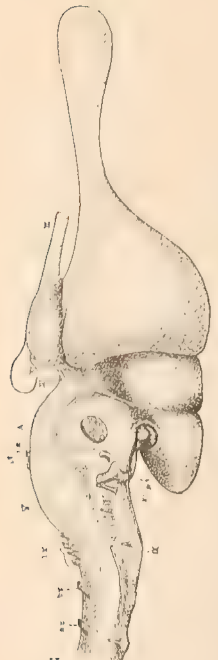
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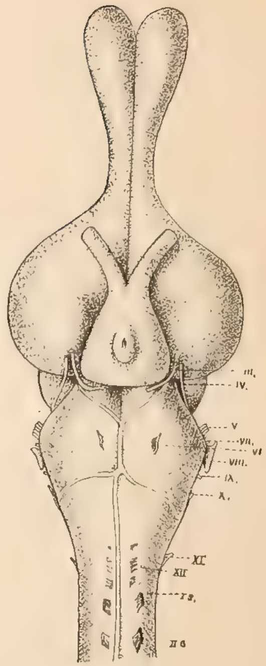
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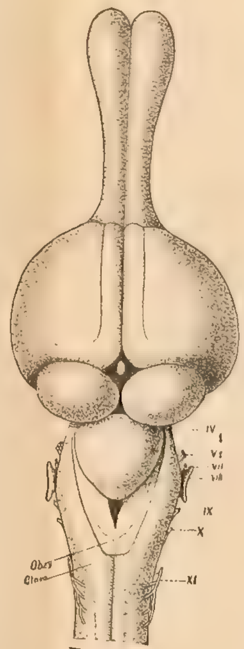
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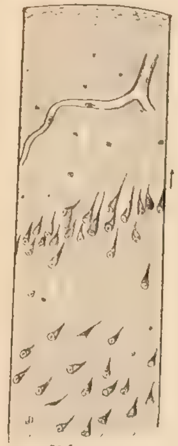
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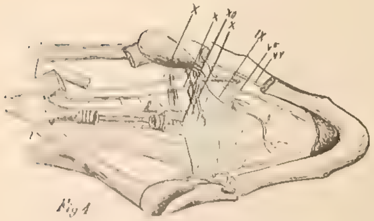
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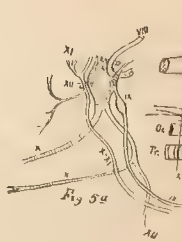
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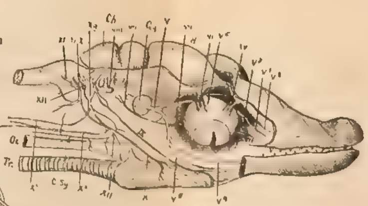
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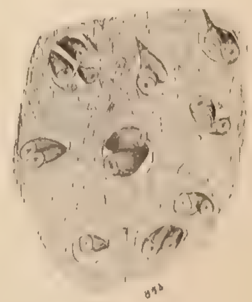
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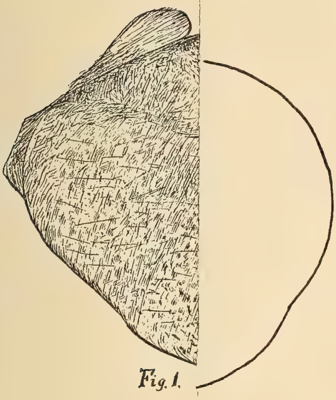

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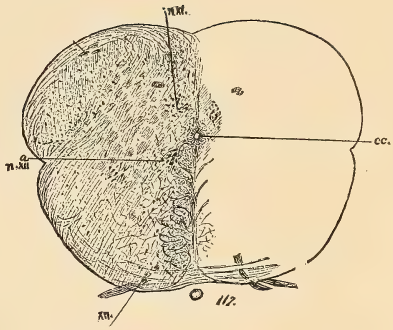

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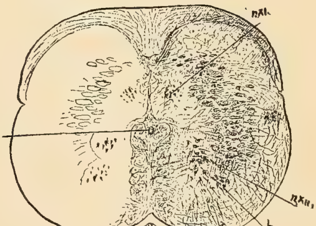

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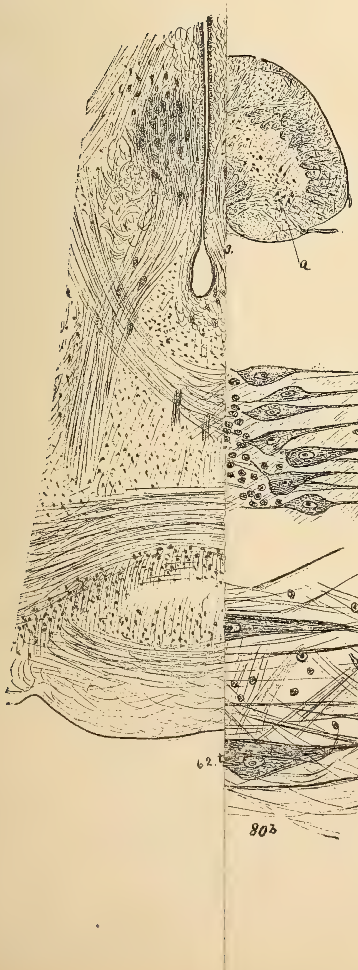

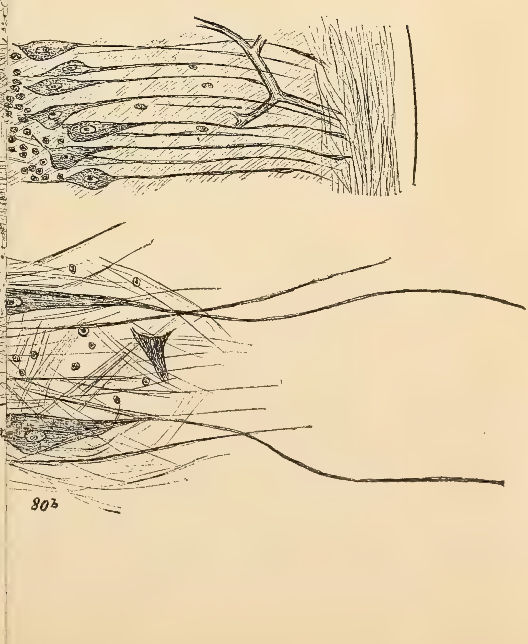

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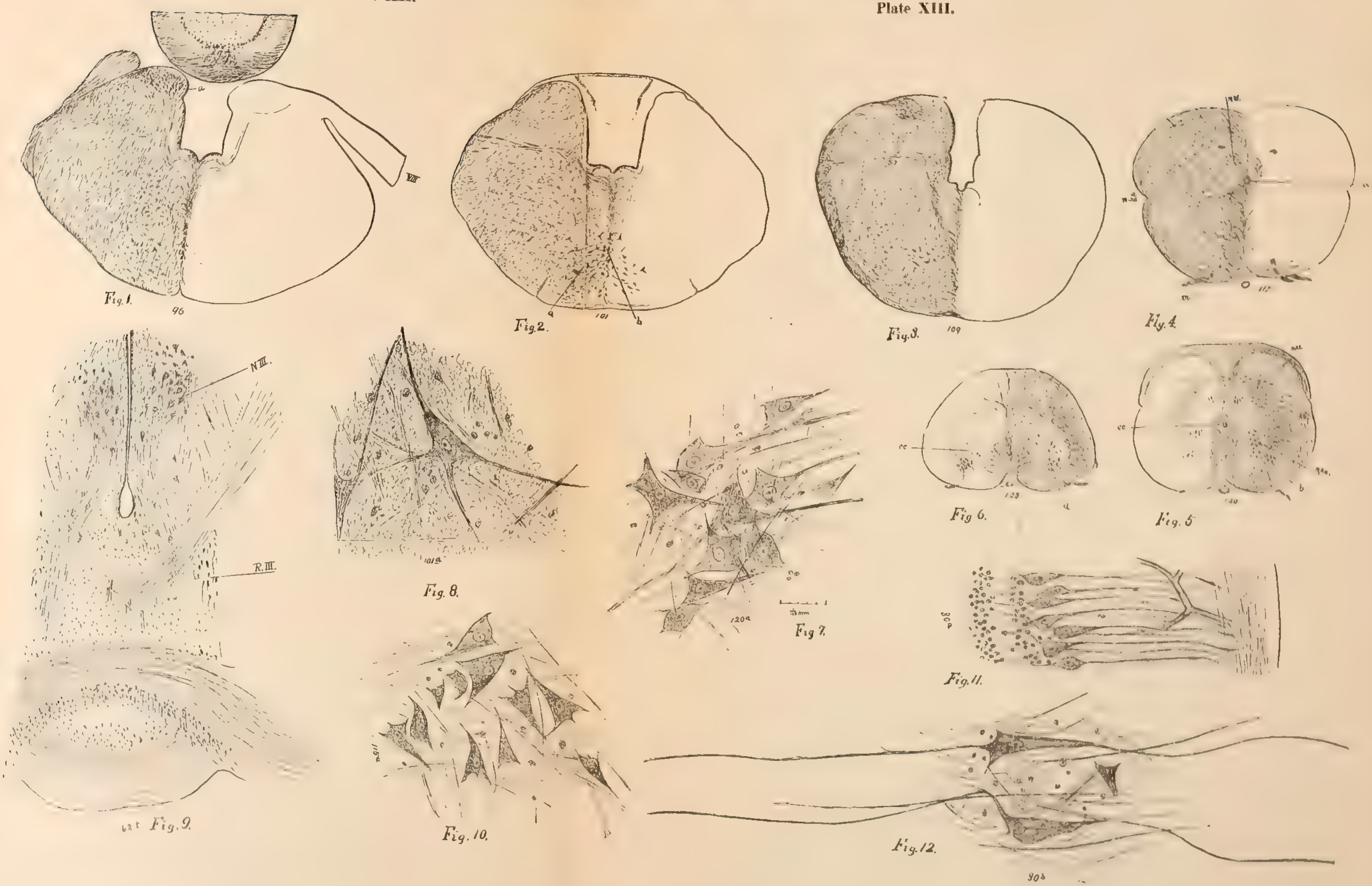

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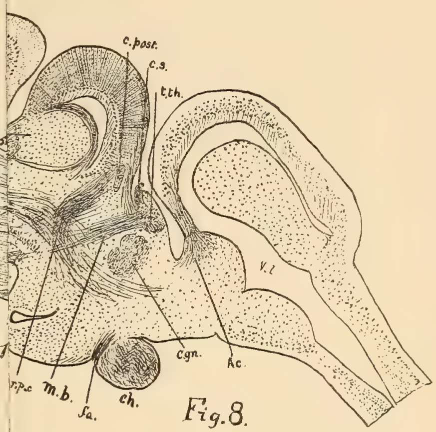

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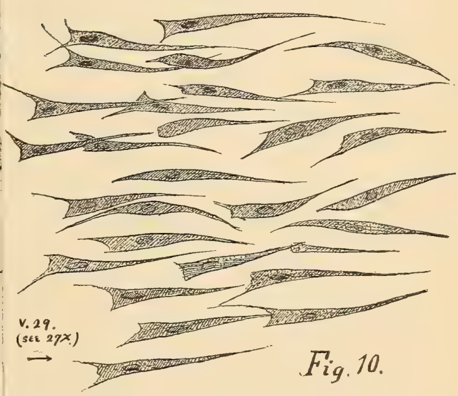

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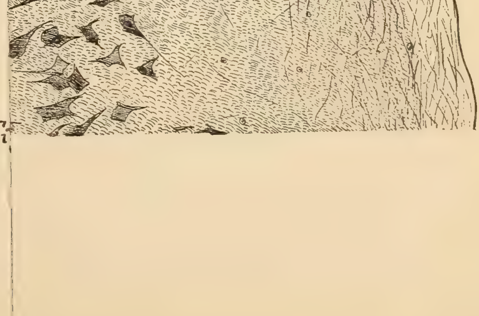

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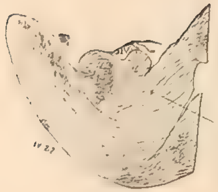

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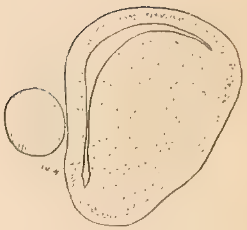

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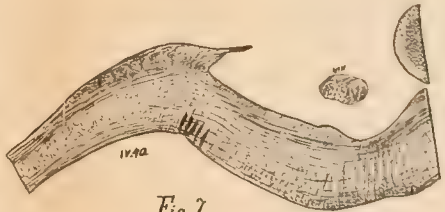

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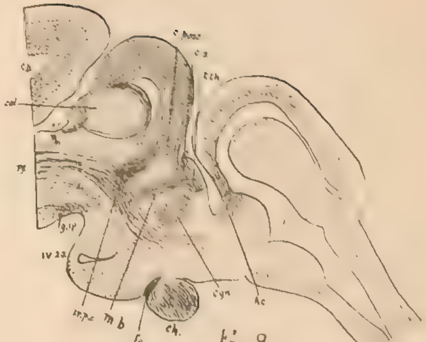

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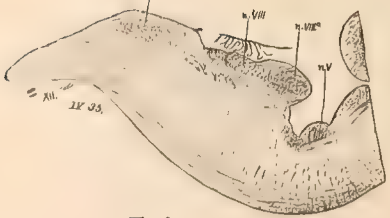

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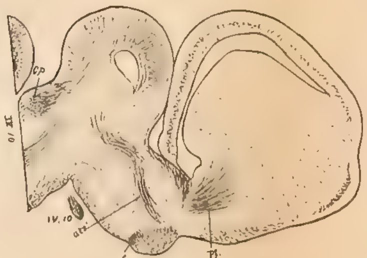

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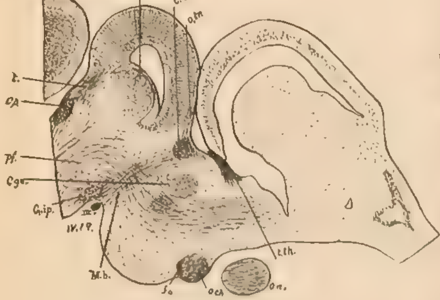

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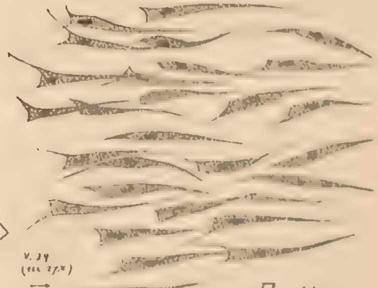

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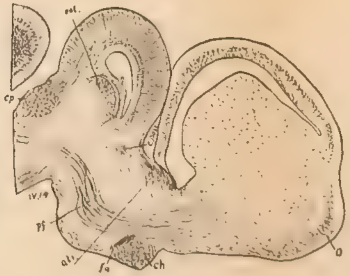

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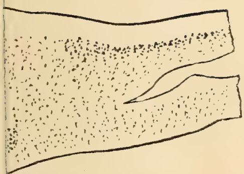

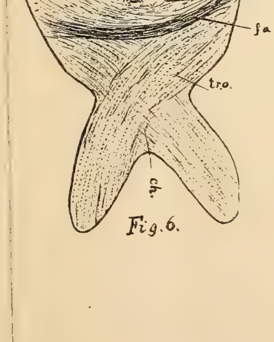

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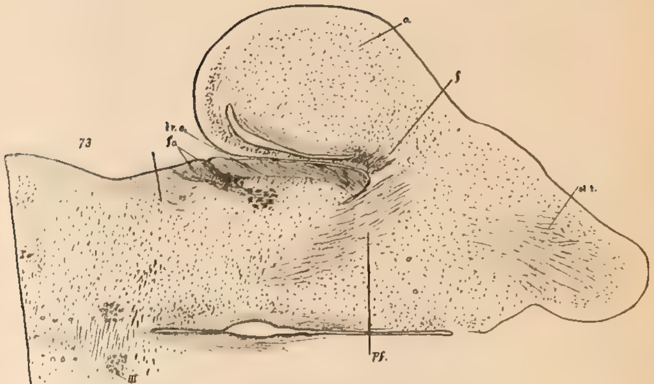

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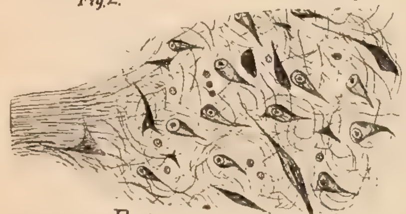

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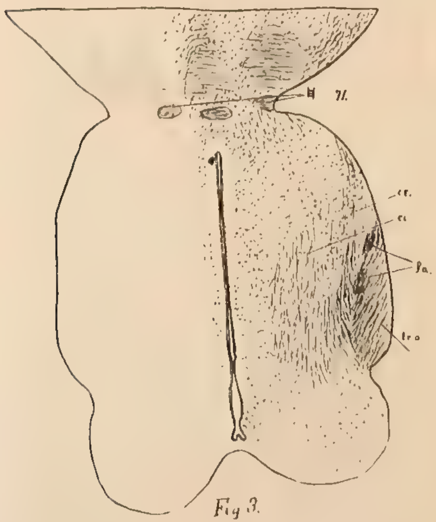

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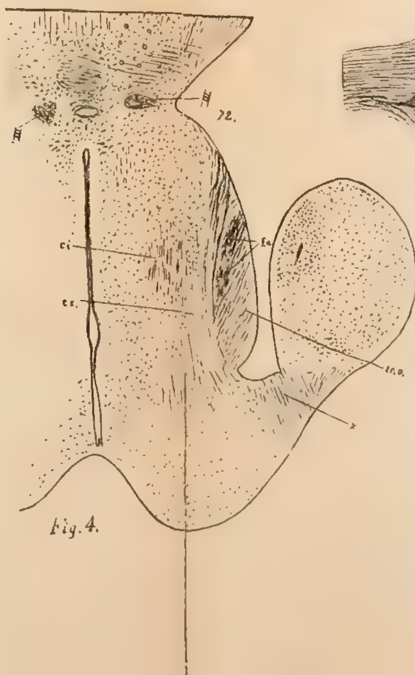

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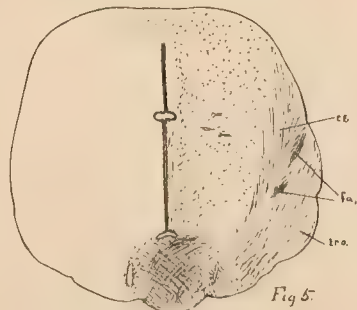

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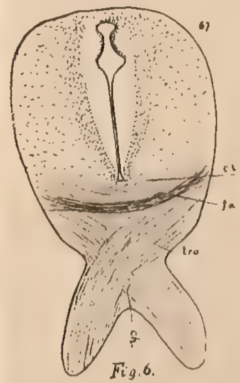

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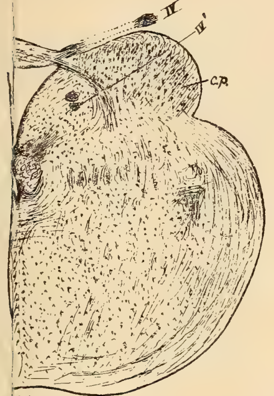

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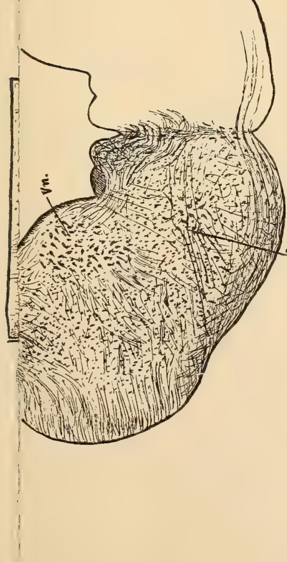

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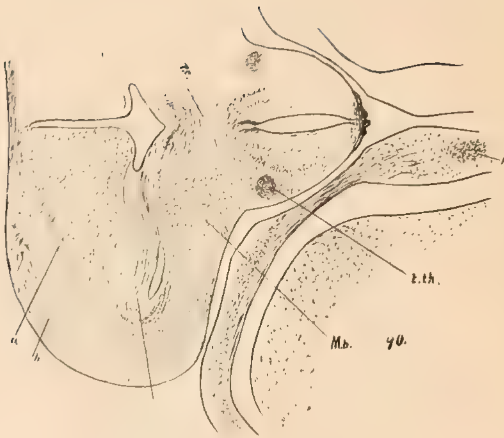

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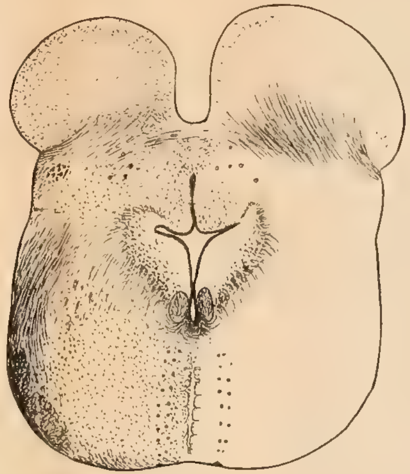

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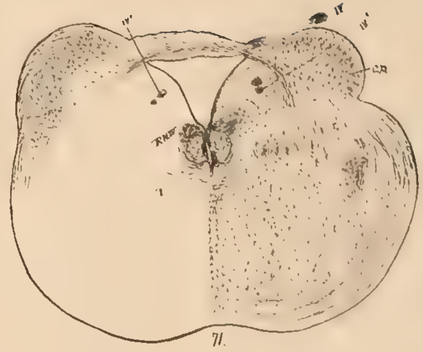

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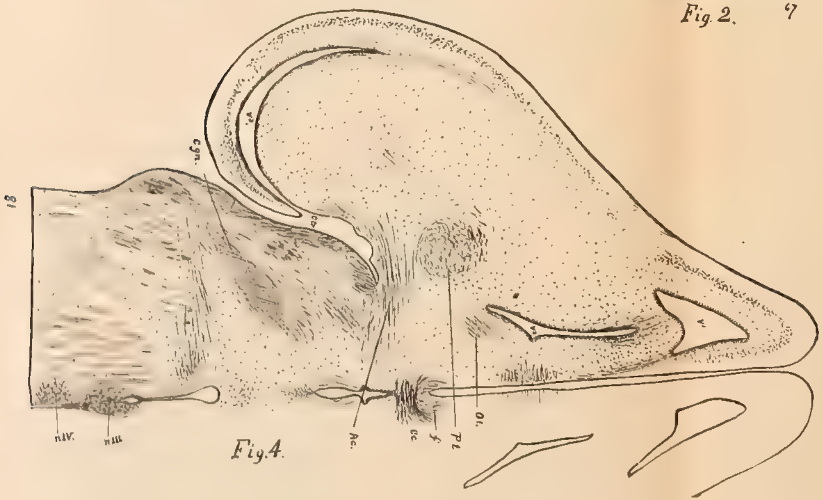

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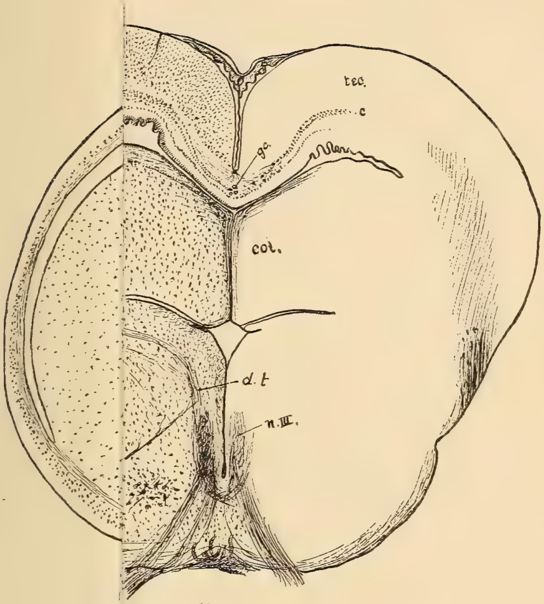

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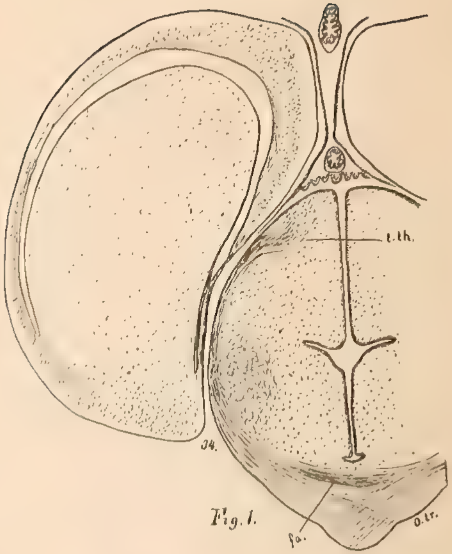

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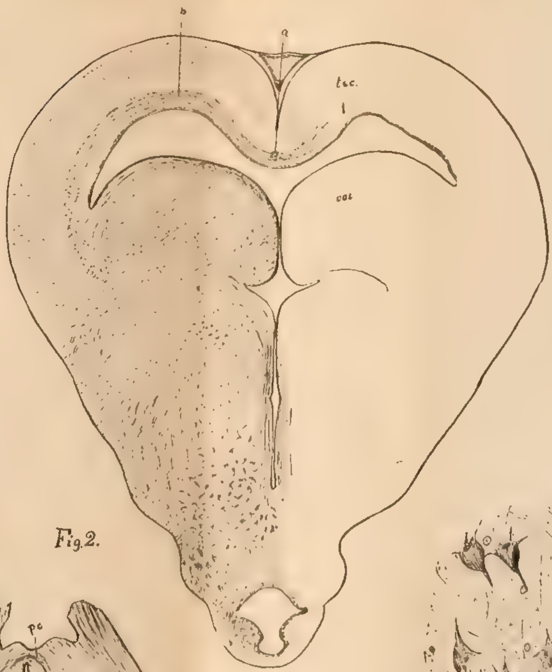

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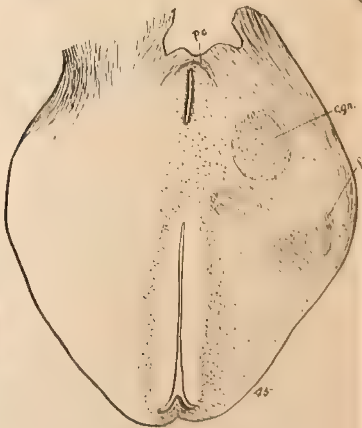

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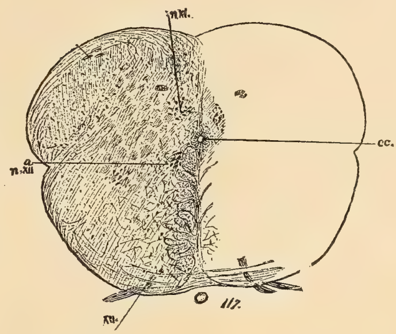

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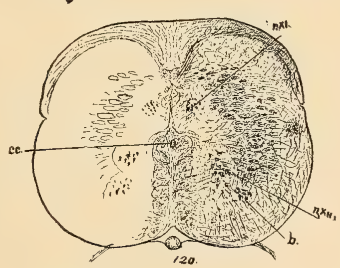

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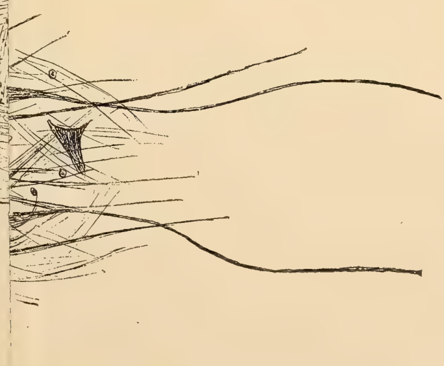

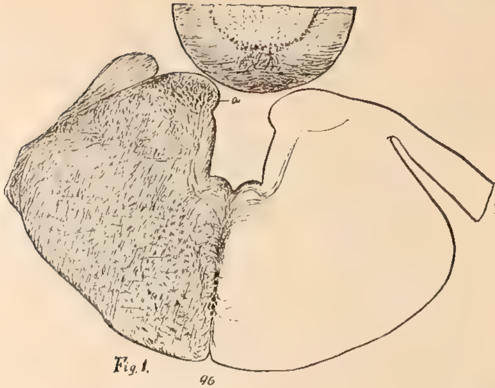

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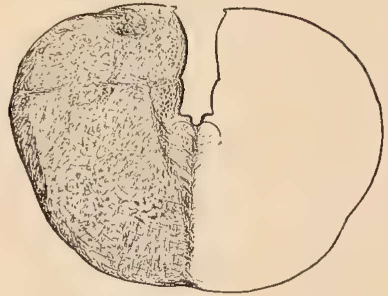

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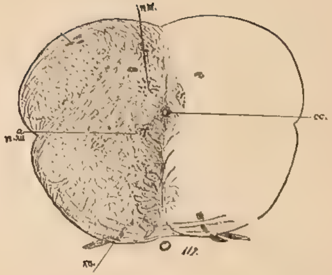

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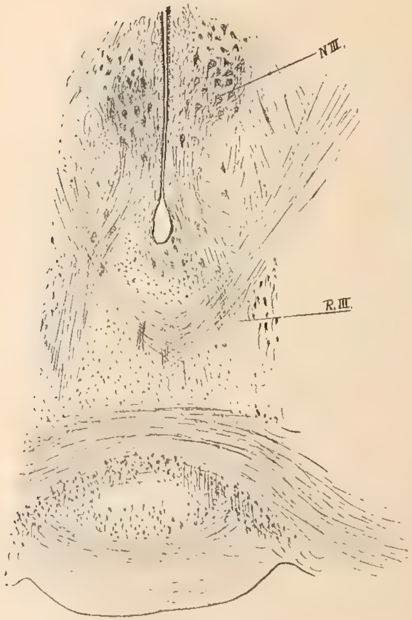

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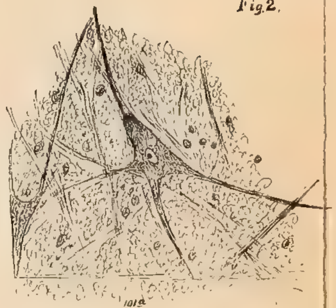

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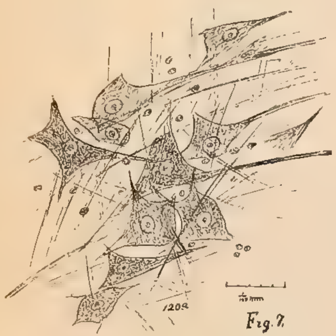

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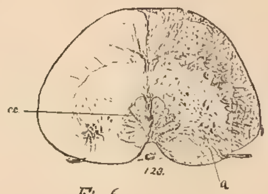

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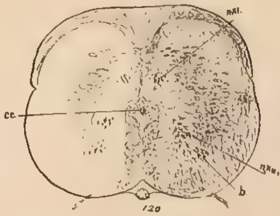

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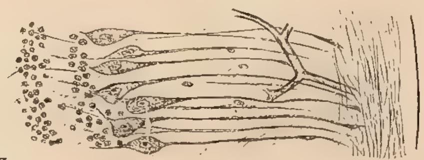

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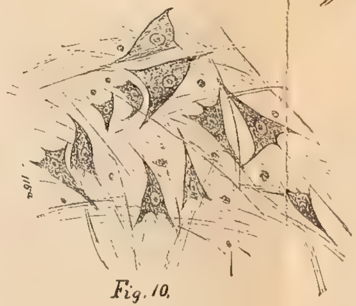

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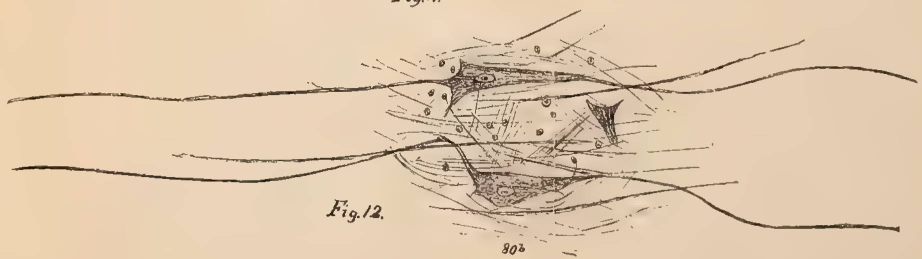

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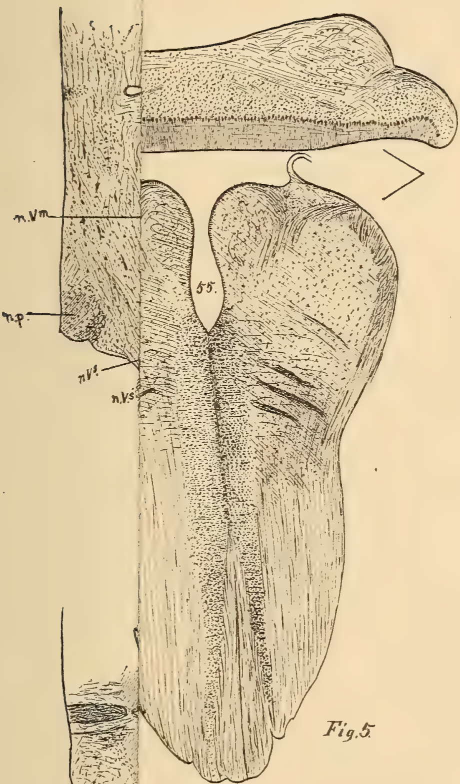

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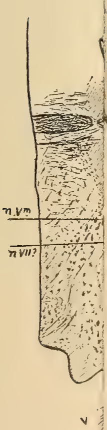

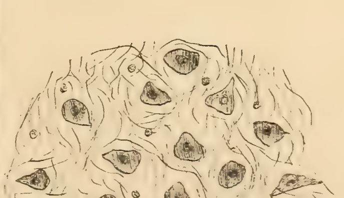

Fig.6.

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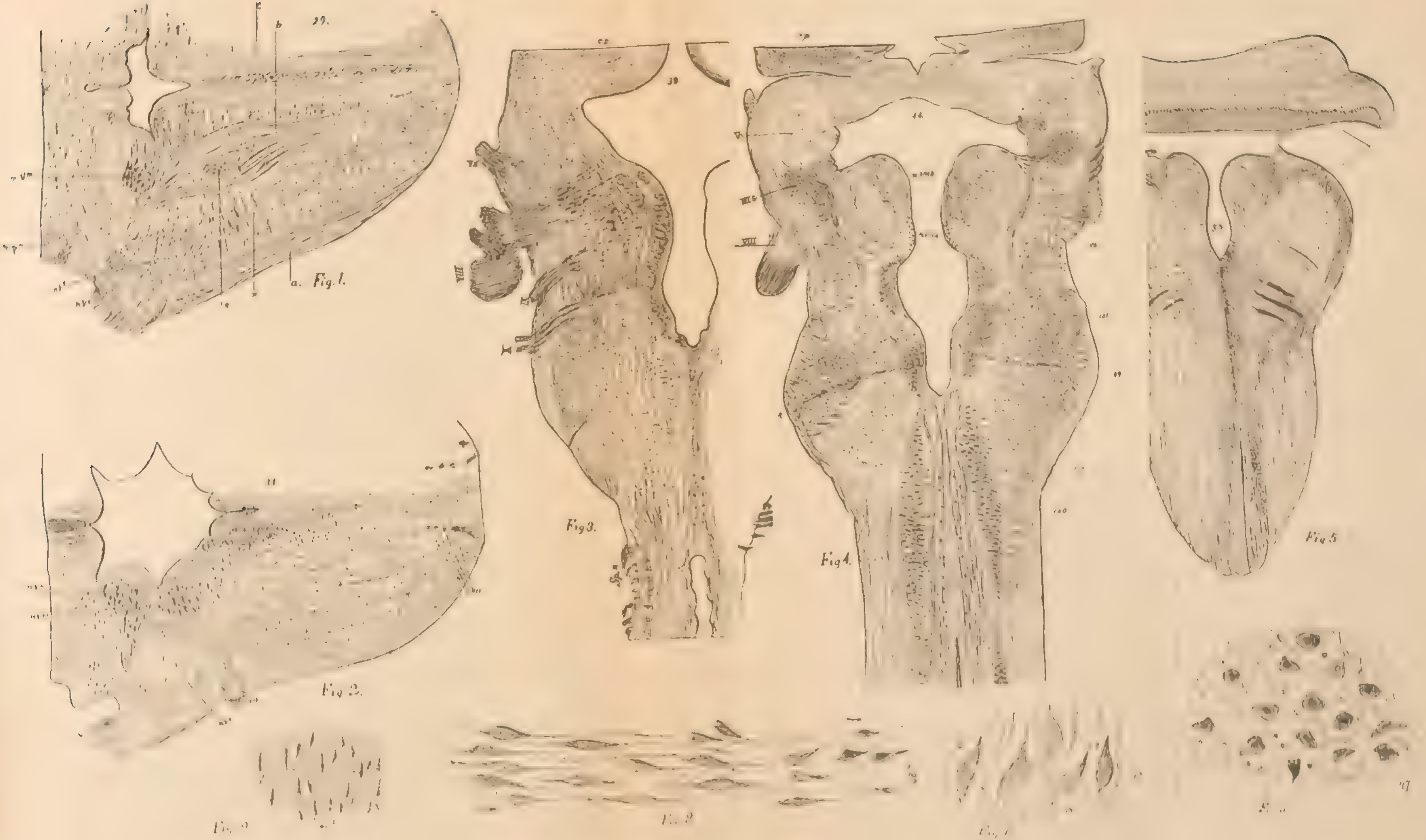

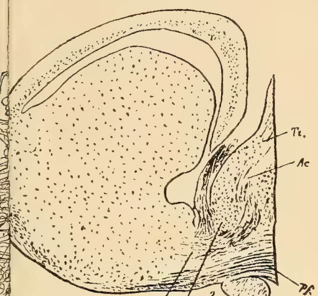

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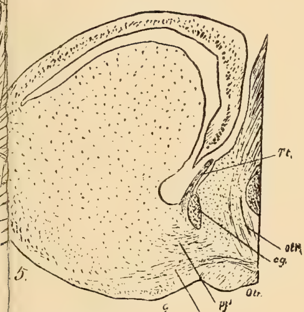

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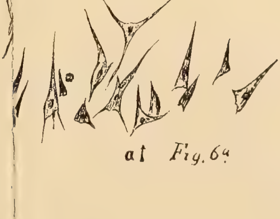
Fig. 6.

III 7.



at Fig. 6a

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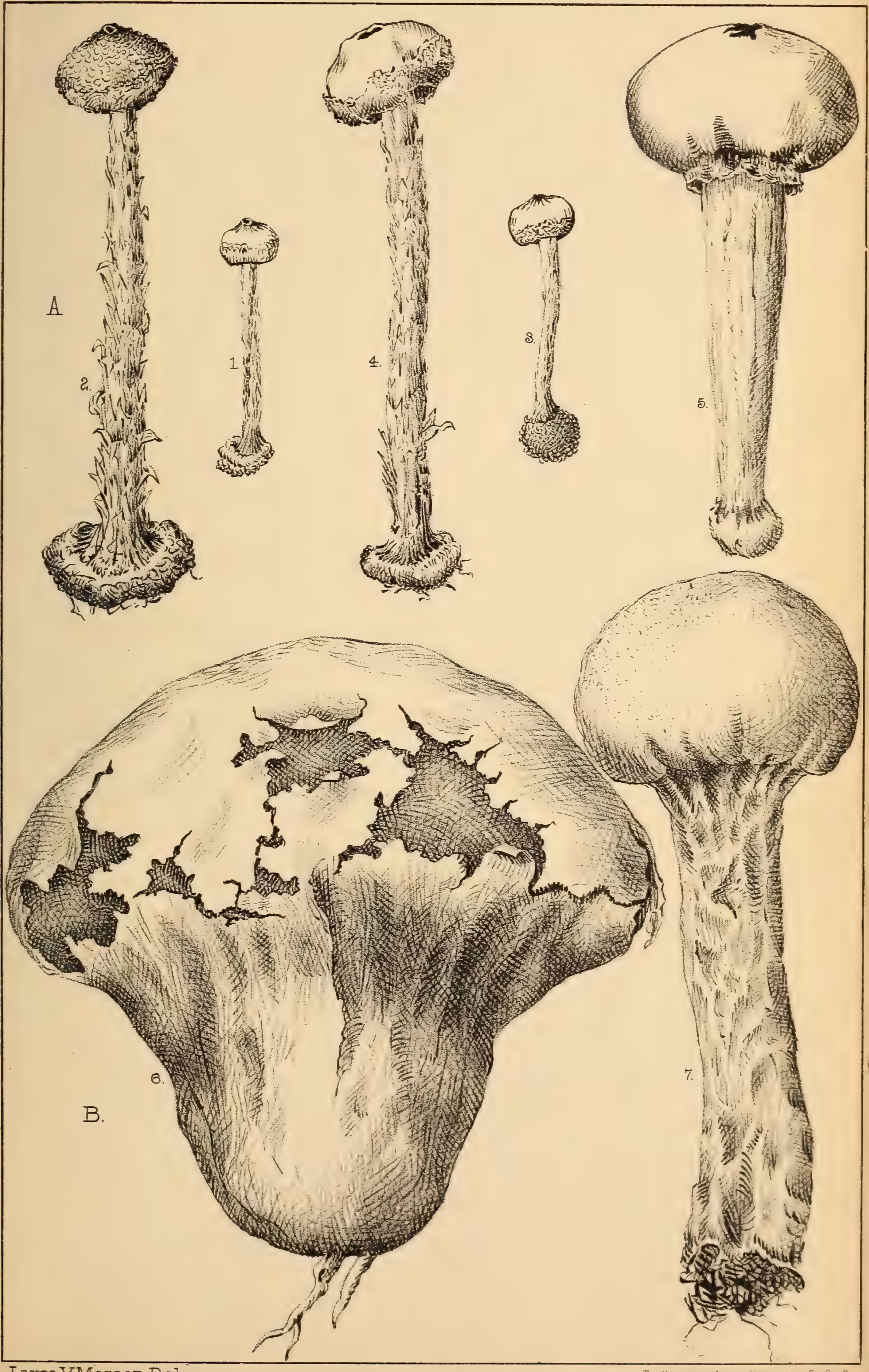

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